Journal
of
Chemical Education

Published by

Division of Chemical Education of The American Chemical Society

Easton, Pa.

Entered as Second class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Accepted for mailing, at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924.

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UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces the following open competitive examinations:

Junior Pharmacognosist, $1860
Junior Pharmacologist, $1860
Senior Chemical Engineer (Pulp and Paper), $5200 to $6000

Applications for the first two positions must be on file with the Civil-Service Commission at Washington, D. C., not later than December 30th; for the last, not later than December 27th.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.

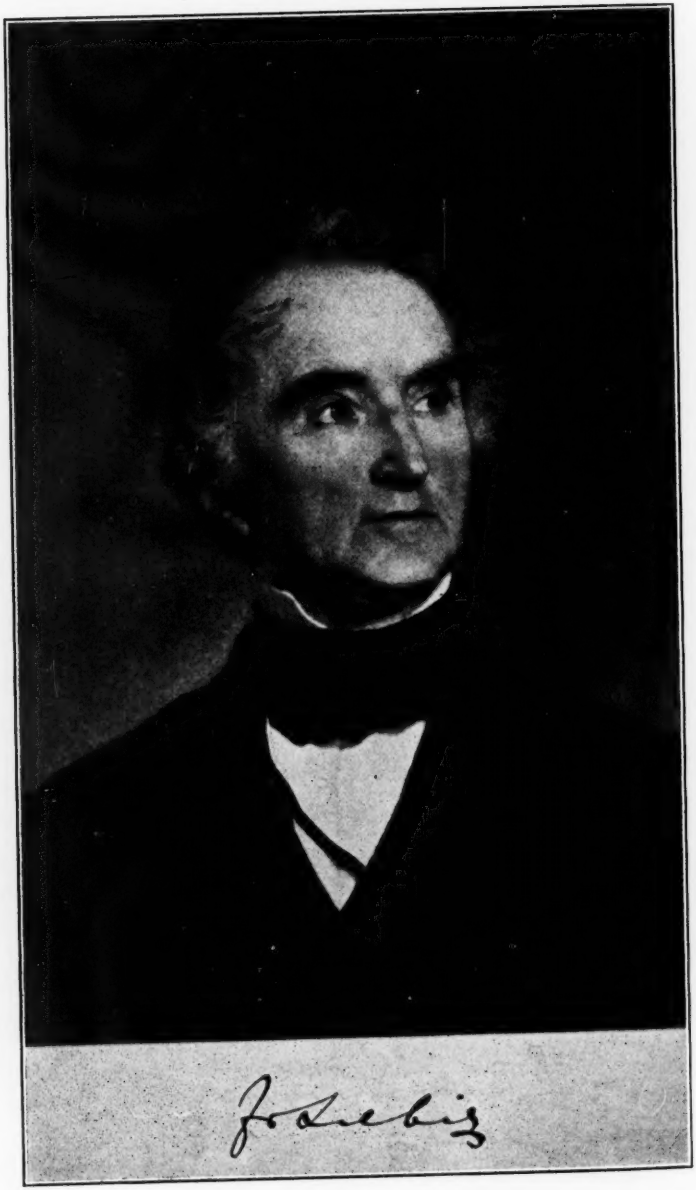
CHEMICAL ENGINEERING CATALOGS FOR DISTRIBUTION

For some years past the Chemical Catalog Company (419 Fourth Avenue at 29th Street, New York City) has been distributing returned copies of the previous year's edition of the "Chemical Engineering Catalog" to various colleges and universities, where they are used in the chemistry departments as supplementary textbooks for the students in chemical engineering. The company announces that it has, this year, a rather larger number of catalogs for distribution than usual. No charge is made for the copies, but the express charges are paid by the receiver.

ORGANIC SYMPOSIUM—COLUMBUS, OHIO, DECEMBER 29–31, 1927

The arrangements for the Symposium are practically complete. The program will occupy morning, afternoon, and evening of each day. The social part of the meeting will be provided by arrangements for those attending to have their meals together, sometimes at the headquarters hotel, the Neil House, and sometimes at the Faculty Club which is next to the Chemistry Building. All phases of the meeting have been arranged to avoid the rush so characteristic of chemical meetings. Only fifteen papers will be presented. Besides these there will be five colloquia on subjects of general interest to organic chemists. The presenters of papers were chosen by a general ballot of the Organic Division last spring. They are as follows:

Roger Adams, University of Illinois; Homer Adkins, University of Wisconsin; James B. Conant, Harvard University; Graham Edgar, Ethyl Gasoline Corporation; Wm. L. Evans, Ohio State University; E. C. Franklin, Stanford University; H. S. Fry, University of Cincinnati; Charles H. Herty, The Chemical Foundation; Arthur J. Hill, Yale University; C. S. Hudson, Bureau of Standards; Oliver Kamm, Parke Davis & Co.; E. C. Kendall, The Mayo Foundation; J. A. Nieuwland, University of Notre Dame; James F. Norris, Massachusetts Institute of Technology; R. R. Renshaw, New York University.


J. v. Liebig

EDITOR'S OUTLOOK

Holiday Musings

THIS number of the JOURNAL appears at a time when augmented professional and personal obligations combine to reduce leisure to the vanishing point. No doubt, in most cases, it will be laid aside for a more convenient season. When the final flurry of themes and papers has been cleared away, when the last desperate shopping sortie is over and New Year's greetings have been hurriedly dispatched to senders of unexpected Christmas cards, when the somnolence induced by feats of gastronomical prowess has begun to wear away—then one breathes a sigh of relief and contentment and settles into an easy chair for a period of reading and musing. It is to such a mood that we address these somewhat rambling remarks.

Once or twice in the course of a lifetime nearly every man is faced with events or combinations of circumstances which compel him to re-examine himself and his ideas on life in general. He who is wise makes inventory at frequent intervals, without awaiting the day of crisis. If no more than a re-affirmation of faith is accomplished, something has been gained. There is, too, a secondary advantage in this volitional resort to introspection. It permits one, now and then, to do his thinking in a cheerful frame of mind. For the external stimuli which drive one to thought are apt to give one's views a gloomy cast. And we cannot agree with the present almost unanimous consensus of opinion among the intellectuals that the gloomiest thinking is necessarily the clearest.

Perhaps some hardy soul will one day hazard a sane defense of optimism, after the natural reaction against the optimaniacs of the Pollyanna school has somewhat abated. Pessimism, like physical pain, has its uses, but it is only to be tolerated so long as it *is* useful. One is astonished to observe the number of people who fail to realize so obvious a truism. They smile pityingly at the person who imagines that he displays or acquires merit by undergoing some minor operation without benefit of anesthesia and they dismiss the flagellants of an earlier day as more than a trifle cracked, but they acclaim with enthusiasm the intellectual flagellants of today. No doubt some children are being raised in ignorance of the fact that "unpleasant truth" is two words.

Having delivered this declaration of independence, let us ask ourselves in all good humor, just how much sound cause we have to take honest pride in our profession. Have teachers, in general, and teachers of chemistry, in particular, a real basis for professional pride? To the writer it appears that they have.

There is a certain tendency to regard the work of the teacher as nonproductive. The teacher (as teacher) contributes nothing to the sum total of human knowledge. He revolutionizes no industries. Does

he, therefore, occupy a position of secondary importance in the scientific scheme of things? Not unless one must ascribe a secondary rôle to the queen of a hive of bees. She gathers no honey; she produces nothing—her only function is to perpetuate the race. A generation consisting solely of scientific "producers" would be as sterile as a colony of worker bees.

If the teacher must count upon a greater time lapse between the sowing and the harvest than the research worker or the industrialist, he may also look forward to more extensive results in the long run. It is scarcely conceivable that any investigator, however great, could, by his own personal efforts in the laboratory, advance the science to so great an extent as can the pupils trained by one good teacher in the course of his working life.

Perhaps it may be hinted that some of us are making a virtue of necessity—that we teach because we can do nothing else. But even though the charge be true we need not take it very much to heart, if only we are good teachers. If rumor may be trusted, about all that Shakespeare could do was to write plays. Caruso never made much of a success of anything except singing. There are many research men who cannot teach and more than one successful plant executive would be a flat failure in the laboratory or the class-room.

But the teacher can, in addition, congratulate himself upon the right of prior possession in a field which has as yet been barely scratched—a field which can never be intensively cultivated except through his efforts. That is the field of humanization. The popularizers of chemistry have made an excellent attack from the journalistic angle, but already they are cramped by the limitations under which they labor. Everywhere they run into a stone wall of ignorance which it is well-nigh impossible to penetrate without violating the space and style requirements which the journalistic medium imposes. Too often, in an attempt to make clear some obscure point, the journalist is forced to resort to similes or illustrations which are seriously misleading in some of their implications. He cannot, in the ordinary newspaper article, build up the background necessary to a proper exposition of the item of news which he desires to present nor to convey a truthful impression of its significance. As a result, the popularization of chemistry has scarcely progressed beyond the propadganda stage. We employ the word propaganda, be it said, in no derogatory sense. It is well that the science should be advertised. Undoubtedly that is the first and one of the most essential steps in our humanization program. But must we forever content ourselves with crying, "Lo here and lo there—see the pretty golden eggs which the magic goose has laid?"

The teacher of chemistry is not oppressed by the limitations which

encompass the journalist. When he finds his audience unequipped for the assimilation of a new idea, he can lay the necessary foundation before proceeding. And in so doing, he should build with an eye to the future. The students of today are the newspaper and magazine readers and writers of tomorrow. It profits nothing that they be crammed with facts to be reproduced upon final examination papers and then forgotten. It does matter greatly that their interests be awakened and developed and that they be given a simple working equipment of fundamental concepts to which the popularizer of the future may address himself with more confident expectation of an intelligent hearing.

Altogether it is not too much to say that the future of the science rests in the hands of teachers. If chemistry is to progress as it should, if a knowledge of its more elementary principles and an intelligent interest in its development are ever to become a part of the national culture, teachers must realize and accept their full responsibility in the matter. Surely these considerations justify a sense of the importance and dignity of the profession.

Tests and Testing

NO REGULAR attendant at educational meetings can have failed to note the sharp diversity of opinion which arises whenever the subject of educational measurement comes up for discussion. Most gatherings seem to be about evenly divided between those entirely apathetic to the subject and those who hold strong views pro and con. Perhaps apathy may also be construed as an opinion, but let that pass. As a rule the debate dwindles down to an exchange of repartee between two or three extremists of opposite camps, who finally retire unconvinced and unconvincing.

To us it appears that some of the most violent opposition to the "new-type" methods of testing may be attributed to misunderstanding of their aims and to ignorance of what may reasonably be expected of them. The same thing may be said of many of the arguments advanced in their favor.

We believe that the "new-type" testers are entitled to a hearing on the ground that they are attempting to attack educational problems in a scientific manner or, at least, with a scientific attitude of mind. They are engaged in an altogether laudable endeavor to subject many matters of opinion to reliable experimental examination. On that basis they are entitled to every commendation and encouragement.

On the other hand we do not hold that the will should be blindly accepted for the deed. We once knew an old gentleman who refused to allow any of his children to drive a horse until they had first demonstrated that they could harness, unharness and otherwise care for the animal. Some such restriction might not come amiss in connection with the "new-

type" testing hobby. It should be remembered that these tests in the present stage of their development are like the early automobiles or radios—far from fool-proof. Like some special pieces of laboratory apparatus, they may give good results for the man who has built and understands them, but they are apt to lead to weird conclusions in the hand of the uninitiated.

Even in the hands of experts they have weaknesses. The criticism most frequently advanced by the opponents of the "new-type" test is that it leads to guessing. It seems to us that this criticism is adequately answered in the scoring system employed, whereby incorrect guesses receive double penalties and hence, by the law of averages, cancel any credit received for correct guesses. A point more often overlooked, but one which seems to us of greater importance, is that guessing and positive knowledge are not the only resources of the student confronted with a true-false or a multiple-choice test. Frequently it is possible for him, by the elimination of answers which he knows to be incorrect, to arrive at the correct one. We should ask ourselves whether or not this negative sort of knowledge ought to be rated upon an equality with positive knowledge.

Furthermore, we should ask ourselves just what portions of our work are subject to objective measurement. The psychologists, or at least some of them, have claimed that "anything which exists, exists in amount and is therefore measurable." But this claim should not be taken too literally. It implies either the denial of the existence of all abstractions whatsoever, or the assertion that all abstractions may be resolved into a number of concrete components. The former, is, of course, unreasonable; the latter is, to say the least, impossible of practical execution in the present state of our knowledge. We should hesitate, therefore, to draw too sweeping a conclusion from the results of any of our present tests.

Finally, it seems to us that too much emphasis has been laid upon the ease of administration of the "new-type" tests, particularly when it is urged that they be used to totally replace tests of the "essay" type. It is true that "essays" are cumbersome to grade—they entail more work and some thought on the part of the teacher. But they offer a means of evaluating a phase of the pupil's training and ability which is secondary in importance only to his actual knowledge, *i. e.*, his ability to express what he knows. Too much emphasis cannot be laid upon this point, particularly if we aspire to endow our courses in chemistry with any cultural significance.

Let us, then, make use of educational measurement devices, where they are truly useful, without impairing the validity of our results by ill-considered interpretation or condemning our tools for failing to accomplishing that which they are not designed to do.

JUSTUS VON LIEBIG—STUDENT AND TEACHER

Ralph E. Oesper, University of Cincinnati, Cincinnati, Ohio

"The child is father of the man" was never better exemplified than in the case of Justus Liebig, for he seemed destined for chemistry by inheritance, home surroundings, and natural aptitude. His father, a dealer in painter's supplies, was a practical chemist of some ability, for he manufactured varnishes, etc., in his own laboratory, carrying out experiments for improving both the manufacturing processes and the products. The store room was lighted by gas at a time when this method of illumination was comparatively rare, and the daily visit of the gas wagon to refill the gas holders of the establishment was always of great interest to the children of the family. This chemical talent was transmitted to the son. The mother, a woman without formal education but noted for her ready wit—always an indication of a quick understanding—managed the store in addition to her household, while her husband spent most of his time in the laboratory where, at an early age, Justus made himself "something 'twixt a hindrance and a help." The boy was soon making experiments on his own initiative and since this was not discouraged, the laboratory became his favorite haunt. He acquired a fund of chemical information, sometimes at relatively great cost. For example, he learned the result of adding a porous substance to a hot liquid when he accidentally dropped a piece of cork into an alcoholic solution of shellac: the boiling liquid burned him badly.

Many of the recipes used by the father were taken from his own small stock of chemical books or from volumes borrowed from the court library. Justus soon learned to read these with insatiable interest, choosing them in no definite order beyond the arrangement on the shelves. By the time he was fifteen he had read every chemical book available to him in Darmstadt, and these included Macquer's Dictionary; The Chariot of Antimony; Stahl's phlogistic works; Cavendish, Kirwan, etc., in addition to numerous papers in Göttling's and Gehlen's journals. In his autobiographical notes, Liebig wrote: "I am sure that this method of reading was of little benefit to me, in so far as acquiring positive information was concerned, but it developed in me a talent which is typical of chemists; namely, the ability to think in terms of phenomena. This faculty can only be developed by constantly exercising this aptitude and, in my case, this was accomplished by attempting to perform, so far as possible, all the experiments described in the books I read. My facilities were very limited, but I repeated innumerable times those experiments I could perform until I could observe nothing new. The consequence was the development of a memory of external appearances, particularly

Justus Liebig

of a delicate recognition of similarities and differences of materials or phenomena. Later, this was of great value to me."

His keen observation and love of experimentation were employed for practical purposes at an early age. The yearly fair brought to Darmstadt a "jack of all trades" who removed spots from clothes, mended pots and pans, and, among other things, sold toy torpedoes containing fulminate. Justus happened to come upon the scene just as a new supply of fulminate was being prepared from materials which he easily recognized as mercury, nitric acid, and alcohol. Of course, he repeated this preparation, and after a few trials he succeeded in producing such excellent torpedoes that they were sold in his father's store. The fulminates were destined to play an important part in shaping Liebig's career. The untimely explosion of some fulminate which he had carried into the school room definitely separated him from the local gymnasium where he had been a most unsatisfactory pupil, not because he was stupid but because he was not interested in the classical education to which he was exposed. "Hopelessly useless" was the verdict of the school master, and the boy was delighted to have unlimited time for his experimentation. Not for long, however, for after he had blown the glass and cross bars of the window of his attic room into the street, even his parents decided that his chemical endeavors must be directed into less dangerous channels. Accordingly he was apprenticed to an apothecary at Heppenheim. Pharmacy at that time was a recognized profession, while a pure chemical career was unheard of. In ten months, Justus mastered the profession and learned the characteristics of the numerous and varied materials which passed through his hands. But his spare time was spent studying fulminates in the privacy of his bedroom and with the usual results. One night the house was rocked by so violent an explosion that the young chemist did not tarry to make any explanation or adieus, but returned to Darmstadt as fast as possible.

What was to be done with such a son? Condemned by his teachers and employer, a danger in the home; the father, who sympathized with and appreciated his son's chemical urge, hesitated to grant his desire to study at a university, because the size of his family did not permit the necessary financial drain on his limited resources. Fortunately, a stipend was granted by the Hessian government and, in 1820, the seventeen year old boy, joyfully and full of hope, entered the University of Bonn.

At that time in Germany, chemistry was usually taught by the professor of natural science or medicine. It was a side issue and in many cases a theologian or jurist could have handled the subject better than those who did. As to the laboratories, they are best described in Liebig's words as "kitchens filled with all sorts of furnaces and utensils for carrying

out metallurgical and pharmaceutical processes; no one knew how to teach chemical analysis." Karl Wilhelm Kastner, who lectured on chemistry at Bonn, was a pharmacist by profession and his reputation as the most noted chemist of that region had brought Liebig to Bonn. The enthusiasm and talents of the young student soon made him the favorite of Kastner and he enticed Liebig to follow him to Erlangen in 1821 by promising to teach him the mysteries of chemical analysis. This promise was not kept, for Liebig soon found that Kastner did not know how to carry out a mineral analysis. The disillusioned student then sought the realization of his scientific ideals in the lectures of the famous philosopher Schelling. "I spent part of my student life at a university where the greatest philosopher and metaphysician of the century cast a spell over the student body. Who was safe from this infection? I, too, lived through this period so rich in words and ideas, so poor in true knowledge and genuine studies; this cost me two valuable years of my life."

He continued to study his beloved fulminates and published his first paper which dealt with the silver salt. His undaunted efforts had brought success, for he reported: "For the past two years I have been able to prepare silver fulminate in relatively large quantities by this method and it has never gone wrong." He spent considerable time in an attempt to fill out the gaps in his interrupted preparatory school training. While at Bonn he had headed a student journal club which met for the discussion of the new discoveries in chemistry, and he organized a similar group at Erlangen. There was another side to his student life, for in his free time he led a merry existence. On New Year's Eve, 1821, Liebig took an active part in a violent town and gown fight and he spent three days in the university jail. The university records state, "this punishment was fully merited, for he was particularly active in this disturbance, he made scurrilous remarks about those in authority, and he knocked the hat from the head of not only police officer Schramm, but even of Councillor-at-Law Heim." (Is there a back door to lasting fame?)

These factional fights continued for weeks and as most of the citizens sided against the students, the situation became so critical that the militia was called in to keep peace. The students, in protest, decided to leave Erlangen and migrate to Altdorf, the former seat of a university. They were cordially received by the citizens of that town who appreciated the financial advantage to be derived from the presence of the school, and a similar realization of the threatened loss of income made the citizens of Erlangen willing to invite the students to return. The demands of the students were met and they marched back into Erlangen with a brass band at the head of the parade, amid general rejoicing by both parties. The militia was withdrawn and the civic and university authorities engaged in a discussion over the payment of the soldiery. The city maintained

that the students' actions made the presence of the militia imperative and consequently the university should pay, while the scholastic heads retorted that the students needed no protection, as they were capable of defending themselves. As a compromise, a small tax was levied on each pot of beer, and each party vied with the other to pay off the debt as quickly as possible. The affair was not over. An investigation was instituted, the action of the students was ascribed to secret revolutionary opposition to the government and Liebig as one of the leaders was placed under suspicion. His friends warned him to leave secretly, but he was reluctant to go before taking his doctorate examination. However, the danger of arrest increased and he finally returned to Darmstadt, where he was later taken into custody, tried, and acquitted.

Liebig now knew that a chemical education was not to be obtained in Germany and he resolved to go to Paris because Chevreul, Thenard, and especially Gay-Lussac were interested in what later became organic chemistry. After his political views were found to be innocuous, he was given a grant by the government. In Paris, he attended the well-ordered lecture courses of Biot, Laplace, Cuvier, Gay-Lussac, Thenard, Dulong, etc., and found in them what he had long desired. "The French lectures appealed to me especially because of their truth and the careful avoidance of all sham explanations; they were the exact opposite of the German lectures in which the scientific teachings were robbed of all of their firm framework by the preponderance of deduction." He continued his studies on the fulminates and an account of his results given before the Academy secured for him the attention of Alexander von Humboldt and the latter persuaded Gay-Lussac to take the young student into his private laboratory. Here he laid the foundations of his method of organic analysis, perhaps his most useful contribution to scientific chemistry. This was not perfected until 1831. Its great advantage lay in its comparative simplicity, for after a little practice any student could obtain reliable results. A criticism of the cumbersome Berzelius method drew a tart reply from the old master, and Liebig asked Wöhler to act as peace maker. "I have not said his method is not good; on the contrary it is excellent. I am sure he does not understand what I wrote, because he does not know my method. He spent 18 months analyzing seven organic acids, with repetitions, say 21 analyses. In three months we have completed 72 analyses, without a failure. Berzelius, with his old apparatus, would have spent five years doing this work." Liebig's combustion furnace was a rectangular shallow iron box through which passed a glass tube sealed at one end, the other end being joined to his well-known potash bulb and a calcium chloride tube. The tube was imbedded in sand and hot charcoal was heaped around it; the rate of heating was regulated by a feather fan and by adding or removing hot coals. This apparently

crude device, at which the modern student would turn up a contemptuous nose, sufficed to make the rapid growth of organic chemistry possible.

von Humboldt spoke so highly of Liebig that in May, 1824, the Grand Duke of Hesse, without consulting the faculty, appointed the young man, then only twenty-one, as extraordinary professor at Giessen. His reception there was by no means cordial. The faculty was as hostile as it dared be, for his colleagues resented the manner in which he had been imposed on them. His youthful enthusiasm for a subject whose claims to be regarded as a science appeared remote to those who knew only German courses of chemistry, made him an object of much unfavorable comment. The ordinarius in chemistry refused all offers of coöperation with Liebig and petulantly removed all the instruments and apparatus from the old laboratory to his home. Did Fate intervene when he drowned while bathing in the river during the summer of 1825? Liebig's irregular education was regarded with misgiving and even his doctorate, which had been granted in absentia at Erlangen in June, 1823, was only recognized after a re-examination at Giessen. His thesis entitled "The Relation of Mineral Chemistry to Plant Chemistry" was a criticism of the existing state of chemical theory and in May, 1823, he wrote to his friend Platen: "It is truly sad to see how the glory of the Germans in physics, chemistry, and other natural sciences has disappeared. The present-day chemist, who has enough to do if he attempts to comprehend his inexhaustible science, bumptiously plays at being a philosopher and as a consequence his exertions go for nothing. It is quite fine, if he views and comprehends his science from a philosophical standpoint, and thereby puts spirit and life into the dead mass, but he may not exceed his limitations as a chemist, since philosophizing may lead to his being ridiculed. We hardly have the laws necessary to bind together even loosely the tremendous structure of our science, nevertheless systematizing is rampant, and the traffic in hypotheses makes one's head swim." Is it strange that such views did not make the keen youth popular with his colleagues, the protagonists of the order he was attacking?

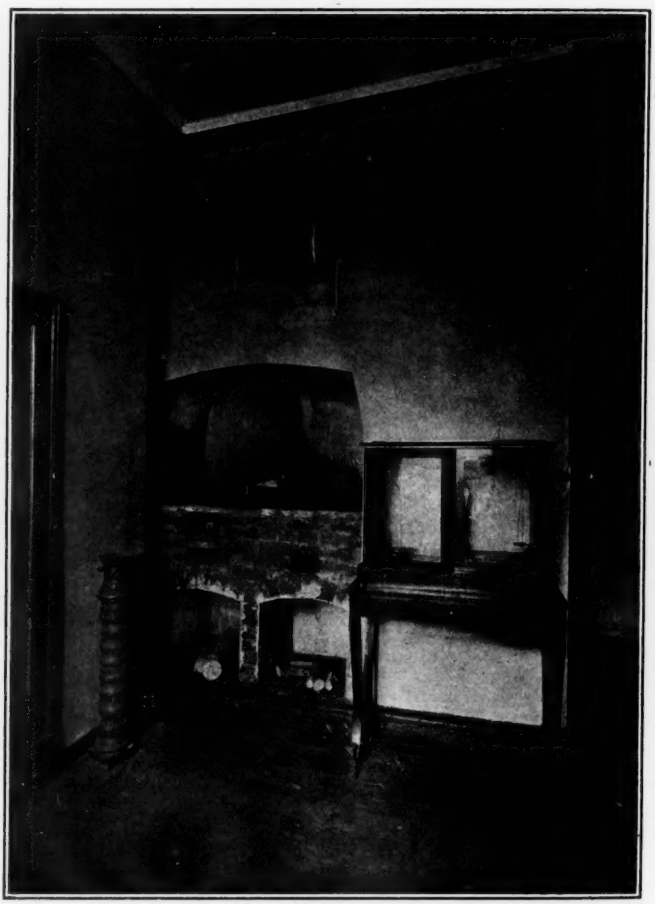
While in Gay-Lussac's laboratory, Liebig conceived the idea of founding a chemical school in Germany in which he hoped to be to his young co-workers what Gay-Lussac had been to him. When Liebig began his work at Giessen there was no laboratory available for him, and he knew from personal experience that a chemical course without practical work was a hollow sham. However, Liebig's talents and engaging personality had so impressed his fellow teachers that after the death of the ordinary professor of chemistry, Liebig was nominated to fill the vacancy and the only dissenting vote was cast by the professor of Hebrew. One wing of a police barracks was placed at his disposal, and the tiny fund allowed for equipment was soon expended. In fact, it was understood that if he was

insistent in his demands, he would have to meet the expense of fitting up a laboratory out of his private income which, of course, was extremely small. In 1840 Liebig wrote: "I was appointed in 1824 at a salary of 300 florins (1 florin = 40 cents) and 100 florins was allowed for laboratory expenses. I began my lecture course and opened a laboratory for practical work. Nothing in the way of instruments, apparatus, or materials was furnished to me. After Zimmermann's death, my salary was increased to 800 florins and the laboratory fund to 400 florins. What could I demand at a time when I was nobody and when there was no one in Germany who understood what I wished or could do? In every issue of

LIEBIG'S LABORATORY AT GIESSEN IN THE YEAR 1841

Berzelius' *Jahresbericht* you will find that this great scientist has noted some of my work as the most important of the year. You might think this would gradually win a place in the world for me. I have already told you of the means at my disposal. If you consider that in a scientific paper practically every word means an experiment and every experiment requires the use of materials and apparatus, in other words, an expenditure of money, you may well ask where I obtained the immense sums required for my equipment and materials, since editors do not pay for chemical and physical papers. I will tell you—the money was borrowed. I had to work steadily for ten years and I was never in a condition to pay my debts. All that I took in was consumed in this way. I was like an alchemist who, in addition to sacrificing his health, puts his own

wealth and all that should belong to his wife and children into the crucible, in the hope of some day finding therein the shining mass of gold. Note this difference, however. My gold was tangible, for I was always



LIEBIG'S PRIVATE LABORATORY AT GIESSEN
Note heating arrangement. Small windows opened from each side for occasional observation of the student laboratories.

seeking to correct an error or to discover a new truth." Liebig's father kept a cash book and this record shows that the son, although a full professor, was often the recipient of a few florins for pocket money.

Volhard has described Liebig's working quarters: "The laboratory,

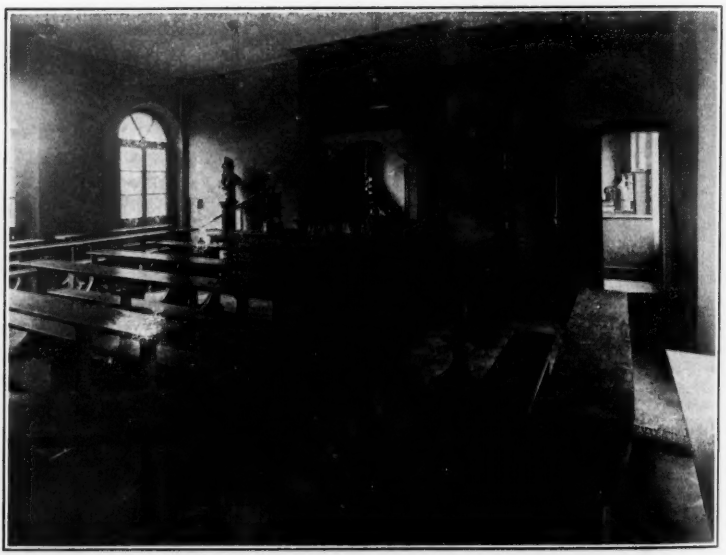
a former guard room, had a floor space of about 38 square meters, *i. e.*, it was about the size of an ordinary living room. A door opened into an open colonnade, where formerly the sentry paced up and down and where the guard was wont to assemble when called out. This open space was used for such operations as involved fire hazard, vile smells, or harmful vapors. A small room served as an auditorium, while in an unheated space, paved with stone and serving as a storeroom, were set up balances and other instruments. Students also worked in another small room which was vacated on wash days, for it was the laundry of the professor's

MAIN LABORATORY AT GIESSEN
Note coal heating arrangement and metal-jacketed condensers with funnels into which cooling water was poured.

family, who were housed on the second floor. There was no private work room or office for the professor.

"Let us enter the main laboratory. For a moment we are in doubt as to which of the eight or nine persons working there is the professor, but it must be he with the strikingly beautiful head and the penetrating, dominating eyes, although he appears to be the youngest of the group. He stands at a work bench, around him the students who come each minute to ask him about this and that. On the center table we see three or four small stoves filled with glowing coals. Gas was not in use at that time and the alcohol flame sufficed for only the smaller vessels. Here a liquid is boiling in a large porcelain dish; there an acid is distilling

from a large glass retort. But this material has its whims, glass is glass. A sharp crack, the retort breaks, the acid runs onto the hot coals, and in an instant the whole room is filled with smoke and choking vapors. Windows and doors are hurriedly thrown open and the master and his apprentices flee into the open air until the laboratory atmosphere has cleared somewhat. Could such changes from the steaming hot laboratory to the outer wintry temperature be beneficial to the health of the professor? Yet he had plenty of opportunities to become accustomed to them, for day after day he spent hours at the balance in the unheated balance room."



LIEBIG'S LECTURE ROOM AT GIESSEN
Note opening (behind lecture table) leading into the main laboratory.

Such conditions prevailed until 1835 and only after Liebig threatened to leave Giessen was the auditorium converted into a balance room, a new auditorium added, and a small private laboratory partitioned off. A second enlargement was made in 1839, and the space was used in this form until 1890, when a new *Institut* was built. The old laboratory has been restored to its former condition and is now a museum. This type of laboratory was found so excellent that it served as a model for the chemical buildings which gradually appeared at other German universities. In fact, its fundamental features were embodied in buildings designed for the other natural sciences, so that it may be regarded as the prototype of all teaching laboratories.

Two students worked in the new "pharmaceutical chemical institute" during the first semester of its existence, but news of what was available at Giessen soon spread, and in a few years students were enrolled from all parts of Europe and later from America. Gay-Lussac sent his son to learn from his former pupil. Knapp, Liebig's nephew, wrote: "At that time, technical education was not highly regarded, although a classical training could not satisfy everyone. Consequently, Germany was full of dissatisfied and undecided young men. There were plenty of gifted sons of good family, but, alas, how many of them wasted their intellectual talents and disappeared from the universities after a short period of dissipation. They thought themselves superior if they looked with contempt upon an everyday life which offered them no real objective. No war was raging and government posts were boresome. The natural philosophers pointed out the depths of nature, but, in spite of much talk, they understood little of natural phenomena. Scientific studies could not flourish if they were founded on theology. Therefore, the tremendous success of the Giessen laboratory. It offered a scene of action for hidden powers in this enervated time. No matter how deplorable the conditions in the rest of Germany, here was a place where no one prevented such men from heating retorts on a sand bath, from separating by analytical methods materials whose composition had hitherto been unknown, from synthesizing and producing crystals of new compounds. Indeed, sometimes it was possible to make in the laboratory substances which had only been known as products of animal life." Where there is no vision, the people perish.

Liebig's success as a teacher was immediate. His wide knowledge, his skill in the laboratory, his enthusiasm, his ability to overcome difficulties, the facility with which he analyzed problems, earned for him the respect and admiration of his students. His capacity for work, both practical and literary, seemed limitless and he demanded and received the whole-hearted coöperation of those working with him. The "chemikers" at Giessen formed a distinct group in the community; they had no time or desire for the ordinary student frivolities. Each was inspired to do his best. "If you want to be a chemist, you will have to ruin your health; no one who does not ruin his health with study will ever do anything in chemistry now-a-days" was Liebig's advice to Kekulé. The student, after preparing the more important gases, was carefully trained in qualitative and quantitative analysis. He was then required to make a large number of preparations; that is, to produce pure substances in good yield from crude materials. Liebig laid great stress on this part of his instruction, for he believed that only in this way could one become acquainted with the properties of substances; in short, this to him was the only way to become a chemist. After this preliminary training, the student

was allowed to engage in original research. The emphasis was always on teaching the students to observe and reason independently. Liebig believed that chemistry was not only a science and a profession; it was also an art which should permit the free play of self-reliant individuality.

The fundamental idea in his teaching was to give a broad basic training without regard to definite technical fields. "A real scientific course should make its graduate qualified to meet and to comprehend all technical applications; a knowledge of the basic laws and principles of the science makes the applications easy of solution; such problems almost solve themselves." Liebig's own achievements in the practical application of chemistry to agriculture, physiology, pathology, and medicine are glowing recommendations of this educational philosophy, and a study of his scientific career will demonstrate that a full knowledge of pure chemistry is essential to the working out of practical problems. He knew the laymen would only appreciate the practical value of new applications of chemistry if the facts and theories were presented in non-technical language and his popular expositions of science have never been surpassed.

Volhard wrote: "Liebig's delivery was not fluent, nor had he a finished style; at times it was almost halting. There were frequent pauses for which the audience could see no reason, and to those not used to his lectures, they were quite painful. At such times, he would stand thinking about the subject he had just been discussing, mentally pursuing his train of thought into regions far beyond the bounds of the lecture, peering before him apparently absent-minded until he suddenly realized that he had an audience before him. He would sigh and resume the broken thread of his discourse. However, his remarks were so thoroughly to the point and so free from rhetorical flourishes, and he brought out the essential features of the subject-matter so clearly, that the hearers had the feeling that they were actually witnessing the discovery of new facts. This directness aroused the keenest interest of the audience; one felt that the speaker believed his science to be of sacred importance, and this devotion soon infected the listeners."

Liebig loved a good discussion, was merciless in his criticism of errors hallowed by tradition or founded on faulty experimentation. In his zeal he often overshot his mark but was always willing to acknowledge his mistakes. "I never care if others pluck out feathers which I intended to drop at the next moulting season; only those who cannot grow new plumage need worry about such happenings." Though his criticisms engendered many enmities, he was always impersonal in such discussions, and he stoically regarded such hard feelings as the inevitable heritage of one holding strong convictions. He once said of Dumas: "He is not a small character, but a man who has had to lay out his own road. Consequently, it has occasionally been necessary for him to poke certain people

in the ribs, and naturally they have not found this pleasant." He once wrote to Mohr: "With me, it is never a question of persons; I consider only the matter at hand. I try to reach a definite objective and if you cannot see my goal, it is your fault, not mine."

On the other hand, Liebig was a distinctly social being. The students

LIEBIG MONUMENT AT GIESSEN

were always welcome to his hospitality, especially on Sunday afternoons when his garden was a favorite gathering place for faculty and students. He loved to dominate the conversation, but he had little patience with long faculty discussions or gossip. Academic administrative offices had no charms for him; he was never dean or rector. He was a good whist player,

and it was distinctly understood that cards and conversation are incompatible. Liebig's friendships were lasting and sincere and a perusal of his correspondence reveals the innate lovableness of his character. His relations with Wöhler formed one of the most beautiful chapters in the history of chemistry. Germinating in a controversy over the fateful fulminates, it grew into mutual admiration, flowered into an abiding friendship whose fruits were an inestimable boon to chemistry. Begun in 1829, it lasted to Liebig's death in 1873, and practically all of their letters to each other have been preserved. Wöhler sent more than 600 to Liebig and received about as many in reply. On December 31, 1871, Liebig wrote: "I cannot let the year run out without giving you a sign that I am still in existence and to send you and yours my best wishes for the coming year. We will not be able to exchange such greetings much longer, but when we have passed away and returned to dust, the ties which united us in life will still bind us together in the memories of men as a rare example of two men who loyally worked and strove in the same field, and yet remained the best of friends with never a trace of jealousy or envy."

The well-deserved success of Liebig as teacher, investigator, writer, and editor led schools of much greater renown and financial resources to envy the little Hessian university, and invitations to leave the modest surroundings at Giessen were not lacking. Antwerp (1835), St. Petersburg (1837), Vienna (1840), Heidelberg (1851), in turn offered inducements of larger salary, better equipment, cosmopolitan atmosphere, royal favor, etc., but all were refused. It was not easy to decline some of these offers. The Hessian administration only grudgingly increased his salary and laboratory funds for, as is the custom of politicians, they neither understood nor appreciated what he had accomplished. In 1840, he wrote: "Nobody in this country understands me or comprehends what I wish and desire. It is impossible to make myself clear. Heaven alone knows whether it is the intelligence or will that is lacking. After I have worked for months studying fatty bodies and oils in order to get facts from which I can get some notion about the formation of these materials in the organism, it is noised about that I am studying the laws of soap boiling. What can I do, but submit to fate?" The citizens of Giessen knew well the financial loss that they would sustain if he left, and on several occasions the municipality offered to lend the necessary funds to the Hessian government, and stipulated that the interest on this loan should be devoted to the natural science departments of the university.

Liebig was a loyal Hessian and he appreciated that his career had been made possible in part or wholly by the aid he had received from the Grand Duke when he first went to Paris and later to Giessen. In 1851 he wrote: "I will not go to Heidelberg, no matter what they offer me, but I shall

remain at Giessen. The thought of founding a scientific school at a neighboring university and of being, in any way, instrumental in destroying that which I have built up at Giessen during the past quarter of a century, the thought of such an action robs me of rest and sleep and makes me sick. I cannot do this thing. I cannot use my strength to demolish what was erected with so much love, effort, and sacrifice. I cannot disturb the work of my friends in Giessen. My life would be stained and I could no longer allow myself to be seen in Darmstadt, and I should feel obliged to avoid my fatherland like a criminal. I am not unaware of the consequences which may possibly follow this decision, but I am willing to take these upon myself. It is certain that my success at Heidelberg would be the ruination of the school at Giessen, which was my joy and my pride, and its downfall would be the calamity of my life." This confidential letter was received by his friend Dalwigk before the administration had announced how many of Liebig's demands for his friends and laboratory would be met. (He asked nothing for himself.) Dalwigk treacherously communicated Liebig's resolve to the ministry and they rewarded Liebig's altruism and patriotism by doing nothing about the matter. Considerably later, a few of his demands were granted and he was given another order as a reward for not leaving Giessen.

In the early part of 1852, Liebig was asked to consider the chair of chemistry at Munich. He wrote to Wöhler: "As to the Munich affair, the king has made me an attractive offer, but I have little inclination to go. The king wishes to influence the agriculturists through me, but that is an old coat that I have taken off and no longer wear. On the other hand, I am attracted by the fact that they are not counting on my teaching activities. Teaching grows repugnant as one grows older." This striking loss of enthusiasm for teaching was undoubtedly due to the burden of daily dealing with the multiplicity of details entailed in the supervision of a considerable number of doctorate researches, and the load was not lightened by the lack of coördinating principles which now systematize and simplify organic chemistry. As early as 1835 Wöhler said: "Organic chemistry nowadays almost drives one mad. To me it appears like a primeval tropical forest full of the most remarkable things; a dreadful, endless jungle into which one does not dare enter, for there seems to be no way out," and Liebig was probably in agreement with his friend. After carefully considering the matter, Liebig sent the following statement to the Hessian administration: "During the present semester I have come to the conviction that because of the constantly increasing number of students, I can no longer conduct the practical work in the laboratory as has been my custom, without seriously endangering my health. This is the chief reason for my decision to leave Giessen and go to another university. In Munich I shall find the relief which I need in

order to devote to science those powers which are still available to me at the age of forty-nine."

Thus closed the most important period of Liebig's life. At Munich he gave no laboratory courses, but delivered lectures both academic and popular. As president of the Academy of Sciences, as advisor to the government in all questions relating to nutrition, natural sciences, agriculture, and industry, he exerted a powerful influence. As editor of the *Annalen* and the *Jahresbericht*, as author of textbooks, he served science in an invaluable capacity. The fruitful brain no longer produced startlingly brilliant ideas as in his younger days. He wrote to Mohr: "Formerly, when a problem presented itself, it seemed as though I had but to thrust my hand into a full basket and draw out the answer, now I have to consider a long time." Twenty years were devoted primarily to literary activities and, when after a short illness, he died on April 18, 1873, there was universal agreement that he had entered into a well-earned repose.

REFERENCES

Henrich, "Aus Justus Liebig's Lehr- und Wanderjahren," *Sitzungs berichte d. physikal.-med. Societät zur Erlangen*, **35**, 125 (1903).

Brand, "Aus Briefen Justus v. Liebig," Festschrift der Universität Giessen, **1907**.

Perkin, "The Modern System of Teaching Practical Inorganic Chemistry and Its Development," *Nature*, **62**, 476 (1900).

Volhard, "Justus v. Liebig, Sein Leben und Wirken," *Annalen der Chemie*, **328**, 1 (1903).

Naumann, "Zur Jahrhundertfeier des Geburtstag Justus Liebig," Braunschweig, **1903**.

Shenstone, "Justus v. Liebig—His Life and Work," New York, **1895**.

Knapp, "Zur Hundertsten Wiederkehr von Liebig's Geburtstag," *Ber.*, **36**, 1315 (1903).

Liebig, "Eigenhändige biographische Aufzeichnungen," *Ber.*, **23**, 817 (1890).

Hofmann, *Ber.*, **6**, 465 (1873); "Unveiling of Memorial at Munich," *Ber.*, **16**, 3103 (1883); "Unveiling of Memorial at Giessen," *Ber.*, **23**, 785 (1890).

Kohut, Justus von Liebig, Giessen, **1905**.

Volhard, Justus v. Liebig, 2 vols., Leipsic, **1909**.

Radio Waves Make Glass Glow Red. Glass tubes, in which have been obtained one of the highest vacuums that man can attain, glow with a strange red phosphorescence under the influence of very short radio waves. This curious effect has been found by Prof. R. W. Wood and Alfred L. Loomis, working in the latter's laboratory at Tuxedo, N. Y., but as yet neither of them can explain just why it happens. They have reported their results to the British scientific magazine, *Nature*.

By means of one of the most powerful vacuum pumps ever made, and of which but a very few are in the United States, the tube is exhausted of air. Previously it has been thoroughly cleaned with chemicals and it is continually heated as the air is removed. After the exhaustion has passed far beyond the point where a high voltage electric current through metal points inside the tube can cause a glow, the oscillating waves are applied. This is with a rather low voltage, and corresponds to radio waves of six or seven meters in length. Then the tube itself shines with a reddish glow.

It is believed that the glow is due to partly broken-up atoms of oxygen from the silicon oxide of which the glass partly consists.—*Science Service*

PROTECTION AGAINST CORROSION BY MEANS OF METALLIC COATINGS*

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As the application of each metal coating for any particular purpose involves specific problems, it is obviously impracticable to consider in a limited space all the various metal coatings and their possible uses. Instead an effort will be made to point out the important factors in the choice of a metal coating for any desired service, and to suggest the methods of testing or investigating the quality and usefulness of such coatings. No attempt will be made to give a bibliography, or even to refer to the voluminous literature on the subject.

As the useful life of a coated article, from the standpoint of corrosion, depends primarily upon the properties of the metal in the coating, we may well ask "Why is not the whole article made of the metal which is suitable as a coating?" In general, an article is coated with a metal, instead of being made entirely of it, either because the coating metal lacks physical properties that are essential to the structure, or because it is too expensive. In either case, the net result (or purpose) is to produce an article which is more resistant than the uncoated metal to external influences such as corrosion or abrasion, and is cheaper or has greater strength, elasticity, or ductility than the article would have if made entirely of the metal used in the coating.

Factors in Corrosion

In considering the usefulness of metal coatings, it is necessary to take into account (1) the metal to be protected, and (2) the environment to which it is to be subjected.

For convenience, the base metals that may be coated may be divided into the two customary groups, (*a*) ferrous and (*b*) non-ferrous. Because of the more extensive use of ferrous metals and their usual greater susceptibility to corrosion, chief consideration will be given to their protection by metallic coatings.

It is impossible to list, much less to classify all the conditions that may lead to corrosion of metals. Purely for purposes of discussion we may distinguish six principal types of environment which are, however, neither inclusive nor exclusive.

(*a*) **Atmospheric Exposure,** in which corrosion may be caused at normal temperature by oxygen, moisture, carbon dioxide, and small amounts of sulfur compounds that may be present in an urban atmosphere.

* Presented at the Institute of Chemistry of the American Chemical Society, State College, Pa., July 9, 1927.

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(*b*) **High-Temperature Exposure.**—Metals may be required to withstand the action of a normal or a contaminated atmosphere at temperatures appreciably above normal.

(*c*) **Aqueous Exposure,** involving continuous or intermittent contact with fresh water which contains only normal amounts of dissolved gases and salts.

(*d*) **Soil Corrosion,** in which attack may be due to water, to air, and to soluble soil constituents.

(*e*) **Marine Exposure,** in which the articles are subjected to the action of sea water. The presence of marine growths on metal surfaces may accelerate their corrosion. Such effects may be due to the action of specific materials (*e. g.*, iodine) present in the growths, or simply to absorption or retention of products of corrosion. Such absorption may give rise to concentration cells.

(*f*) **Chemical Corrosion,** in which the surface is exposed to attack by gases, spray, or liquids containing specific corroding agents such as acids, alkalies, and salts.

(*g*) **Accelerated Electrolytic Corrosion,** such as may be caused by stray currents from power and railway lines.

Types of Protection

Granted that a given metal, otherwise desirable because of its structural properties, is readily attacked under one or more of the above conditions of exposure, it may be possible to protect it by metallic coatings that act in either of two distinctly different ways.

1. **Mechanical Protection.**—If a metal that resists corrosion under the specified conditions could be applied to the base metal in an absolutely continuous coating, the article would have, from the standpoint of corrosion, all the properties of the coating. Such a condition represents an ideal that is seldom approached, and almost never reached in practice. Actually, metal coatings produced by any method are almost certain to have numerous pores, and even if initially impervious, they are likely to become porous through abrasion in service.

The result of such porosity is usually more serious than simply the exposure of small areas of the base metal to corrosion at the normal rate. Most metal coatings that furnish only mechanical protection actually accelerate the corrosion of the base metal. Thus a thin coating of copper on steel usually causes the steel to rust more rapidly on the exposed parts than if no coating were present.

2. **Electrolytic Protection.**—Metals such as zinc and cadmium when applied to steel may exert good protection against corrosion of the steel even if the latter is exposed on small areas. This is simply because the zinc or cadmium, under the conditions existing, has a higher solution pres-

sure than the iron, and hence becomes the anode in the electrolytic cell that is set up. (This form of expression avoids the existing confusion in the use of "positive" and "negative" in connection with the single potentials of the metals.)

Necessarily such protection is exerted only to the extent that the metal coating is itself attacked or dissolved and this practice is not a satisfactory method of preventing corrosion when appearance is also an important consideration. In the latter case, recourse must be had to metals of the first class, that themselves resist corrosion but furnish only mechanical protection, and every effort must be made to produce impervious coatings. The ultimate choice is usually a compromise between appearance and protection.

Methods of Applying Metal Coatings

The most important ways of applying coatings of one metal upon another are:

1. **Hot Dipping,** in which the articles are dipped into a molten metal. For practical reasons this procedure is confined almost exclusively to low melting metals such as zinc, tin, and lead. Hot dipping is by far the most extensively used method of coating metals. It is applied on a large scale in the hot galvanizing of sheets and wire; and in the manufacture of tin plate for canning, and of terne plate for roofing. (The coating on terne plate is an alloy of lead and tin.)

2. **Cementation,** in which the goods are heated with a powdered metal to temperatures approaching the melting point. The most common example is sherardizing in which steel is heated with zinc dust containing a small amount of zinc oxide. It is likely that in this process the zinc deposit is produced partly from the zinc vapor, which alloys with the steel, and also probably cements the zinc particles to the surface.

"Calorizing" is done by heating in aluminum powder, while "chromizing" is conducted similarly with powdered chromium (mixed with aluminum oxide). In both of these methods the resultant alloying is probably due to diffusion of the coating metal into the crystals of the base metal.

3. **Electroplating,** by which coatings of most metals may be produced by depositing the metal from an aqueous solution of its salts. Metals such as magnesium and aluminum cannot be plated from aqueous solutions, because their deposition requires a much more negative potential than is needed to discharge hydrogen from such solutions. The deposition of these metals from non-aqueous solutions, though possible, has not proved practicable. Fused electrolytes such as are employed to produce or refine magnesium and aluminum are not suited for electroplating.

4. **Metal Spraying.**—By the Schoop process and its various modifica-

tions, most metals that are obtainable in ribbon, wire, or powdered form can be sprayed onto the surface of other metals. Such coatings when produced in an oxidizing atmosphere are likely to contain oxide and to be porous. More nearly impervious coatings may be produced in an inert atmosphere, *e. g.*, of nitrogen. One advantage of this process is that it can be applied to large structural members in place.

5. Rolling.—It is possible to produce coated metals, *e. g.*, in the form of sheets and rods, by rolling or drawing a billet on the outside of which slabs of the coating metal have been welded. Familiar examples are gold-filled jewelry, copper-clad steel, and the original Sheffield silver plate. Such coatings are likely to be thicker and more nearly impervious than most other coatings. They have the disadvantage that in fabricating articles from them, edges of the inner base metal are likely to be exposed.

Experience indicates that for active metals such as zinc, the protective value of the coating depends much more upon the average or minimum thickness of the coating than upon the method by which it has been applied. Many specifications make no discrimination between hot dipping, sherardizing, and zinc plating, but simply require that the coating must withstand for a specified period some accelerated test such as the salt spray or intermittent immersion.

For other metals such as lead, tin, copper, and nickel, the value of the coating depends more on the porosity than upon the thickness except so far as the thickness affects the porosity.

Chemical Properties of Coatings

The choice of a metal to be used as a coating depends largely on its chemical properties, while the relative quality of coatings of the same metal is determined principally by their physical properties. The former will be considered first.

As above indicated, metal coatings may furnish either mechanical or electrolytic protection. It is not possible, however, to divide the metals into two corresponding classes, as the kind and degree of protection furnished by a given metal depends upon the metals to be coated, and also upon the environment.

The most common (but often unwarranted) assumption is that the protective value of various metals is determined by their positions in the electrochemical series. The order of this series varies according to different authorities, but for purposes of illustration we will assume that it is as follows: magnesium, aluminum, manganese, zinc, chromium, iron, cadmium, cobalt, nickel, lead, tin, hydrogen, copper, silver, mercury, platinum, gold.

If this series is a true index of corrodibility, we might expect all metals

above iron to protect it electrolytically; and those below iron to accelerate its corrosion. Practically it is found that zinc and cadmium protect iron, while aluminum furnishes much less protection than might be anticipated, and chromium actually accelerates atmospheric corrosion of iron.

The discrepancy arises from the fact that such a table is based on static or equilibrium potentials, while corrosion is dynamic and not static. The anode polarizations on two metals, *i. e.*, the difference between the static and the dynamic potentials when the respective metals are corroding at a given rate or with a given current density, furnish a much better index of the relative tendencies to corrode, than do the static potentials. High anode polarization is an indication of passivity, such as is observed with chromium and aluminum under most conditions of exposure. Such metals then behave like noble metals. Still other factors may be involved. The respective hydrogen overvoltages or the overvoltages for cathode reduction of oxygen or oxidizing agents may determine which of two metals in contact with each other will become anodic and which cathodic.

The equilibrium potentials of cadmium and iron are uncertain though many tables place cadmium slightly below (more noble than) iron. The fact that cadmium does actually protect exposed iron against corrosion in sodium choride, is no necessary evidence that the standard potential of cadmium is more negative than that of iron. It may depend on a lower degree of dissociation of cadmium chloride than of ferrous chloride. This possibility emphasizes the fact that the standard potentials represent the behavior of the metals in comparable environments (usually with hypothetical normal ion activities), and give no direct evidence of their behavior in solutions of widely different ion activities.

Physical Properties of Coatings

1. Average Thickness.—Even though the average thickness of a metal coating is no necessary criterion of its protective value, it frequently serves for the comparison of products finished by the same process. The presence of a certain average thickness, as computed for example from the weight of coating per piece or per unit area, is no guarantee of good quality; but its absence is usually an evidence of inferior quality. Other things equal, thick deposits of the active metals such as zinc and cadmium will last longer than thin ones. Similarly, thick deposits of the more noble metals such as copper, nickel, and chromium, are likely to be less porous than thin ones. In fact, the use of relatively thick coatings, or of multiple layers of considerable total thickness, is one of the few promising ways of making such coatings impervious.

Many metals, *e. g.*, zinc, cadmium, tin, and chromium can be dissolved quantitatively from steel by the use of appropriate solutions and their

amount determined by the loss in weight. Metals that cannot be removed without attacking the base metal must be determined analytically in the resultant solutions.

2. Distribution.—The uniformity with which the coating is applied is often more important than its average thickness. For a given metal this distribution on an irregularly shaped article may vary greatly with the method of application. Thus hot dipped zinc coatings are likely to have thick parts from unequal drainage and may fill up small holes and screw threads, unless the coatings are wiped while hot as on sheets or wires, or unless articles such as nuts and bolts are centrifuged. Wiping may, however, lead to excessively thin spots. Sherardizing produces the most uniform distribution. Acid zinc plating baths have poor throwing power, while the cyanide zinc baths have good throwing power and produce more uniformly distributed deposits.

There is no simple satisfactory method of determining the distribution of a coating. The Preece test, in which zinc-coated articles are dipped in neutral copper sulfate solution till the zinc is entirely removed and copper deposited adherently at some spot, gives a rough indication of the minimum thickness of coating and its location. For zinc-and cadmium-coated steel, exposures to salt spray and to intermittent immersion in sodium chloride or ammonium chloride solution until rust appears, are in effect simply methods of detecting the thin spots in the coating. At best these are slow and unsatisfactory methods of test. Spot tests, depending upon the time required for a given reagent to dissolve the coating and expose the base metal, are not yet standardized and are at best useful only for factory control. There is a great need for further study of quick reliable means of determining the distribution of coatings.

3. Continuity.—Slight porosity of zinc and cadmium coatings is not necessarily detrimental, which is fortunate, as there is no simple way of detecting it. Pores in coatings of noble metals on steels can be readily detected by the ferricyanide test, in which a jelly containing sodium chloride and a soluble ferricyanide, is applied to the surface. The number and size of the blue spots that appear in a few minutes is a direct indication of the probable protective value of the coating.

When salt spray and intermittent immersion tests are applied to steel coated with metals such as nickel and chromium that are at most but slightly attacked by the solution, the appearance of rust is more an indication of the porosity of the coating than of its thickness. The difference in time required for the rust to appear on different samples, and the size and number of the spots, depend apparently on the number, size and permeability of the pores in the deposit.

4. Adhesion.—Both the mechanical and electrolytic protection of a coating in actual service will be materially decreased if the coating does

not adhere well. If it is actually detached from the article, large areas of the base metal may be exposed. If it merely separates slightly, it furnishes an opportunity for moisture or other corroding agents that may penetrate the pores in the coating, to attack the base metal, and cause serious corrosion under the coating.

There is no standardized test to determine the degree of adherence of a coating. Bend tests of coated rods or sheets, or Erichsen ductility tests of sheets, may make a rough distinction between coatings that respectively adhere very well and very poorly.

With plated coatings the adherence depends largely upon the method of preparing the surface by the various cleaning and pickling processes. It is at least doubtful whether any appreciable alloying occurs between a plated coating and the base metal. With hot dipped and sherardized coatings, the alloying which occurs may contribute to the adherence.

5. Ductility.—The adherence of a coating when subjected to bending or elongation, depends in part on the ductility of the coating. The structure and physical properties of a plated coating can be controlled over fairly wide limits by attention to the conditions of deposition. In general, deposits with a coarse structure that are relatively soft and ductile, are produced at a high bath temperature, low current density, high metal-ion concentration and low hydrogen-ion concentration; *i. e.*, under conditions in which the cathode polarization is low. Recently it has been claimed that by annealing hot galvanized coatings, *e. g.*, on wire, the adherence and ductility of the coating are improved.

There is no direct method of testing the ductility of an adherent coating, though tensile tests of coated wires and strips give some indication of this property. Tests made on films deposited on a graphited surface and stripped may be misleading, as the structure and properties of the deposit are affected by the surface on which it is deposited.

6. Hardness.—There is no single significant definition of hardness, a term which may refer to resistance to deformation or to wear of widely different types. In most cases the hardness of metal coatings involves resistance to abrasion. In some cases the hardness as measured by scratch tests has corresponded to the actual service, *e. g.*, on printing plates which are exposed to abrasion by pigment particles. It is not safe to assume, however, that relatively small differences in hardness, as measured by the scratch test, will necessarily correspond to similar differences in wear resistance under other conditions. Such methods as the Brinell and scleroscope tests are usually not applicable to thin coatings, as the results depend largely on the properties of the underlying base metal. As above indicated, the hardness of an electrodeposited metal can often be controlled by the choice of plating conditions.

Practical Applications of Typical Coatings

In order that this paper may not be entirely veiled in generalities, the foregoing principles will be applied in connection with the utility of various metal coatings. For convenience, the protection of steel, brass, and aluminum will be considered.

1. **Protection of Steel.**—For protecting iron and steel against atmospheric, aqueous, or marine exposure, preference should certainly be given to zinc or cadmium coatings, unless, as on exposed parts of automobiles, appearance is also an important consideration. Accelerated and service tests show that under most conditions, and especially for marine exposure, a given thickness of cadmium exerts better protection than the same thickness of zinc. The cadmium itself is less rapidly attacked than the zinc, because it has a lower solution pressure than zinc and because its potential is closer to that of the iron. If iron is exposed, it accelerates the corrosion of the cadmium less than it does that of zinc. However, it is necessary to have more nearly impervious coatings of cadmium than of zinc, as the cadmium exerts its protective action over a smaller area. Whether the added protective value of cadmium compensates for its greater cost, is yet to be determined, though in general the cost of the metal in the coating is only a small part of the whole process. Cadmium plating has not yet come into extensive use. It has proved especially useful on small, accurately dimensioned parts where the thinner coatings are advantageous. The comparative softness of cadmium renders it more subject to abrasion.

For protecting exposed steel where appearance is essential, the present choice is between nickel and chromium plating. Thin coatings of either of these are likely to be porous, and hence to furnish incomplete protection. This can be improved by using thicker coatings, *e. g.*, at least 0.025 mm. or 0.001″. Still better protection is obtained with multiple coatings, such as nickel, copper and nickel, to which now chromium is also being applied. By this latter method the tarnish and abrasion resistance of chromium are obtained without the expense (especially for electrical energy) involved in producing thick chromium deposits. The chief limitation to the more general adoption of chromium plating is the poor throwing power which renders difficult the plating of irregularly shaped articles.

For roofing, so-called terne plate is extensively used, in which the coating is produced by dipping in a lead-tin alloy, containing from 60 to 80 per cent of lead. It is necessary to have some tin (at least 20 per cent) present with the lead in order to produce adherent coatings. The tin content of the terne plate is kept low for purposes of economy. Terne plate is generally used for roofing instead of galvanized sheet because it is easier to solder the seams in terne plate and paint adheres better to terne plate than to galvanized iron. Painting of the terne plate usually

serves to fill or cover most of the pin holes in the coating and thus prevents or retards corrosion of the iron that would otherwise be exposed.

For protecting steel against corrosion at high temperatures, metals of relatively high melting point must be used. For many such purposes calorizing has proved useful. In such cases the protective film in actual service probably consists more largely of aluminum oxide than of aluminum. Chromium is especially promising for this purpose, whether applied by chromizing or by plating. The latter coatings are harder, but more brittle, and may flake off, especially if too thick. Tests on small samples under tension at 650°C. (1200°F.) in air have shown that a thin chromium plating (*e. g.*, 0.005 mm. or 0.0002″) doubles the life of the steel, which without the chromium corrodes rapidly. Chromium is being used successfully on glass molds and on rollers used for plate glass.

Resistance to steam at high temperatures and pressures, *e. g.*, in valves and turbines, involves both corrosion and abrasion. The latter precludes the use of relatively soft coatings. Here again, chromium is receiving careful consideration and will probably find a definite use.

No metal coatings have thus far proved successful for protecting iron or steel pipes against soil corrosion. Metals such as zinc or cadmium are likely to be attacked and dissolved too quickly. Other metal coatings, especially as applied to the imperfect surfaces of commercial pipes, are certain to be porous and may actually accelerate the corrosion.

Protection of steel against chemical corrosion depends, of course, on the materials to be resisted. Lead is most useful to protect against sulfuric acid, as on storage battery fittings, chemical tanks, etc. Many sulfur compounds such as hydrogen sulfide are resisted very well by chromium, which is hence used on rubber molds and on oil-cracking equipment. Tin withstands many organic acids; and silver is often used on chemical equipment to resist alkali at high temperatures. Cadmium is more suitable than zinc where alkaline solutions are involved.

The protection of chemical laboratory fittings and equipment is very involved, and no metal (not even platinum) can be expected to resist all the fumes that may be present. Unless hydrochloric acid fumes are prevalent, fairly thick chromium coatings are likely to prove more generally useful in the laboratory than any other metal coating.

The extensive use of tin plate, especially in the canning industry, is an example of protection against chemical action, the nature of which may vary greatly with the contents of the can. In most cases this use of tin depends upon the fact that it is less readily attacked by organic acids and other food constituents, and is less toxic than most other metals. There is still much uncertainty as to the electrochemical behavior of tinplate in service. Such coatings, like others, are invariably porous. We might, therefore, expect the tin to accelerate the corrosion of the steel

and cause perforation, which is true under certain conditions. Under other conditions, however, the tin often acts as the anode, *i. e.*, it has a greater solution pressure than the iron, and hence dissolves. This solution of the tin is accelerated by the presence of depolarizers, *e. g.*, oxidizing agents, such as the colors present in fruit juices. These complications in the behavior of tin cans illustrate the importance of getting more specific information on hydrogen overvoltage and oxidation-reduction potentials.

2. Protection of Brass.—While brass (and copper) resist actual corrosion under most normal conditions, they tarnish readily, and for the sake of appearance must usually be plated. Nickel and chromium are the only metals commonly used on brass. Chromium is now being applied to a considerable extent on plumbing fixtures, where its resistance to tarnish and to abrasion are especially valuable. Satisfactory coatings of either nickel or chromium on brass may be quite thin (and porous) as there is apparently little tendency for brass to corrode if exposed on very minute areas. Where resistance of brass to specific chemical action is required, it is usually desirable to apply fairly thick coatings of both nickel and chromium.

3. Protection of Aluminum.—The present extensive use of aluminum and its light alloys, especially for aircraft, has been attended with the difficult problem of protecting them against corrosion, especially atmospheric and marine. Thus far no electroplated metal coatings have proved entirely satisfactory for this purpose. At best it is difficult to produce adherent coatings of any metal by plating on aluminum. The initial adherence may be improved by slightly roughening the surface, *e. g.*, by etching or sand blasting. But such coatings are not impervious, and as all the metals that can be plated are more noble than aluminum, they tend to accelerate its corrosion. Protection of such alloys can be obtained with aluminum oxide films, preferably treated with oil. The application of pure aluminum to duralumin by metal spraying has been found to increase greatly the resistance to intercrystalline corrosion. Recently aluminum has been applied to duralumin by rolling, producing aluminum-clad sheet which will probably resist corrosion.

Conclusions

From the foregoing it may be seen that metal coatings furnish no panacea against corrosion, though they are frequently useful. In the latter cases their value depends largely upon the chemical and physical properties of the coating, which cannot be safely taken for granted. There is a large field for research to improve and standardize existent methods as well as to develop new methods. Such work should include not only obvious subjects like metallography and electrodeposition, but also numerous problems in physical chemistry. The mechanism of corrosion and

the effects of such factors as anode polarization and hydrogen overvoltage, must be better understood before it will be possible to properly select, specify, and test protective metal coatings to resist any given conditions of service.

The present demand for conservation of metals and for prevention or reduction of the large waste caused by corrosion, justifies far more extensive and fundamental studies of protective coatings than have been thus far conducted. Here is another opportunity for the colleges to cooperate with industry.

Chinese Drug Found Not So Potent As Adrenalin. The Chinese drug, ephedrine, that seemed for a time to rival the effects of adrenalin, the extract of the suprarenal glands famed for its so-called power to bring the dead to life, is not so potent as was at first believed, according to a report just made to the American Pharmaceutical Association.

Ephedrine was isolated from a Chinese plant in 1887 but first received serious consideration in recent medicine through the researches of Dr. K. K. Chen at the University of Wisconsin. There seems to be little doubt that the drug possesses considerable merit in raising blood pressure but recent investigations undertaken by Dr. L. W. Rowe, of the Parke, Davis & Company Laboratories, indicate that there is little evidence that it will supplant adrenalin as the first clinical reports led many physicians to believe. The reasons for the high hopes of the earlier investigators lay in the facts that ephedrine could be given by mouth instead of by injection and had a more prolonged action on the heart than adrenalin.

Dr. Rowe's work has shown that the new drug has a more lasting action when given hypodermically in large doses but that its value when given by mouth has been somewhat exaggerated. In general, he believes that its qualitative action is similar to that of adrenalin in several respects but that it is much less powerful.—*Science Service*

Pressing Kills Germs, German Scientist Finds. Science has discovered that the pressing of clothes has a higher function than that of merely keeping a knife edge crease in trousers. Prof. M. Hahn, director of the Berlin Hygienic Institute, has recently performed experiments with mechanical ironing machines whereby overcoats, trousers and blankets were completely sterilized of disease-producing bacteria.

Through the entrance of steam into the ironing plates, a temperature of from 212 to 223 degrees Fahrenheit can be obtained in a few seconds, the scientist and his assistants report. This can be raised to 252 degrees in a comparatively short time. The time period is so measured that every fabric, according to its thickness, is exposed to the steaming from twenty-five to thirty seconds.

Thick overcoat materials, which had been smeared with many kinds of dangerous bacilli, and camel's hair blankets were found to be entirely freed, by the ironing process, of pus-forming bacteria and germs closely related to the typhoid bacillus. Tuberculosis bacilli placed in trousers' pockets were killed in thirty seconds by the application of steam. Spore-forming bacteria required longer treatment. At least eight minutes of ironing was necessary to destroy these resistant types, it was found.

While disinfection apparatus is still advisable for rendering a large quantity of materials free from germs, the use of ironing machines is especially valuable for small- and moderate-sized hospitals, sanatoriums, hotels, and sleeping cars, Prof. Hahn pointed out, because the apparatus is inexpensive and easy to operate.—*Science Service*

SOME ASPECTS OF CHEMICAL EDUCATION IN CHINA*

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During a term of service as a chemist-teacher in the Orient, the writer has been in close touch with problems of chemistry teaching in China. A visit to the United States seemed an appropriate occasion to put some of these into written form.

It is wrong to think that civil war and political changes occupy the entire attention of the populace of China. These things are rather the occupations of the select few militaristically inclined. Many of the pitched battles which receive front-page mention in the daily papers are comparable to first-class strikes in this country. Meanwhile, chemical laboratories and educational institutions operate as part of the usual current of daily existence, with little more than momentary interruptions. Many of the colleges are quite removed from the war zone and are unaffected by the present political turmoil.

The first impression made upon the teacher of chemistry, and the first problem he must solve is concerned with the tremendous memory capacity of the Chinese student. The memory function has been over-exercised for the past 300 years until it has almost stifled every other type of mental effort, including the capacity for original thinking. The old Manchu imperial system of education is generally held responsible for this type of intellect. It is probably a mistake to describe this highly developed memory as an innate racial characteristic of the Chinese, since different habits of thought did hold sway in previous eras. Most of the oft-repeated stories about students memorizing entire textbooks have not been overdrawn. The tale that two examination papers, written by two students independently, may read the same, word for word, reflects an everyday experience of the chemistry teacher in China.

The writer's first reaction to this state of affairs was to omit entirely the use of a textbook. This deprived the student of the bound volume of memorizable material which to his mind represented the entire content of the course and the scope of the final examination. It was like depriving him of the ground he stood upon. But this did not solve the situation, for the same student, led by the same habit, memorized the lectures—again without going through the thinking process. The next step was to omit both text and lecture so that the student received his ideas solely through the medium of the laboratory and from the conversational discussions in the class conference. It was later possible gradually to introduce books for reference use only. Now this may be related to the same problem that faces the teacher in America, except that in China this stu-

* Paper presented by title before the Division of Chemical Education of the A. C. S. at Detroit, Mich., September 7, 1927.

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dent disease is far more acute. The deep-rooted character of the original disorder is partly explained by the fact that the common word "to study" in China literally translated means *to repeat the book*. The best results are being obtained by teachers who resort to a vigorous application of the inductive method. Another satisfactory method is to give the class work using the English language as the medium, say, and then to require reports and examinations to be written in Chinese, or the reverse process may be applied. Some teachers insist that this is the only way to insure that the ideas of the lesson have been really absorbed and digested by the student.

Akin to the desire to memorize is that characteristic of the Chinese mind delighting in philosophic contemplation which fails to respond quickly to the inductive method. The story is told of an elderly mandarin of the old regime who, after watching with keen interest a tennis match between two foreigners, turned to his host and asked why the foreign gentlemen did not hire two coolies to hit the ball and to do the strenuous running about the court for them. There is a lot of Oriental philosophy in this episode. Why then, says the student in quantitative analysis, should I determine the amount of chlorine in a sample of pure sodium chloride when it can be found more exactly by calculation? This attitude of mind is being attacked by using unknowns in analysis instead of knowns, and by the greater use of the problem method.

Chinese educational leaders are asserting that China's greatest need is the scientific method. The Chinese youth does not live in an atmosphere of motor cars and of electric power developments; the sections in his physics text on electricity are charged with no sense of relationship to his daily experience; this gap must be supplied in some manner in the class-room. Nor does he live in an atmosphere of meters, of precision, and of accurate thought. One of the most used words of every-day life in China is the word meaning *approximately*, or *about*. The language of every-day speech does not possess the definite grammatical construction which can be used to accurately describe a laboratory experiment with minute exactness. There is a complete lack of the inflections and declensions that make the European languages exact. The unit of length, the *foot*, is a unit which varies for the different materials which are being measured; there is the *lumber foot*, the *cloth foot*, the *silk foot*, etc. The *catty*, the unit of weight, which we standardized in connection with some recent experiments, was found to vary from 0.7 to 1.8 pounds. All this indicates that it is not merely an individual student's mind which must be educated to an appreciation of the finer values of quantitative analysis, but the entire thought life of a people 400,000,000 strong which has to be disturbed. This is not an attempt to insist that the Chinese are not happier with their unscientific weights and measures, but is merely a statement of actual conditions.

Laboratory instruction has only been in progress for about 15 years in China. About a dozen university centers throughout the country are now well-equipped with modern laboratory buildings; in addition there are secondary schools equipped in a more modest manner. Educators are insisting that the inductive method of the laboratory is the wedge which is to overthrow China's non-scientific habit of mind. This means that the stage is already set; the chemistry teacher in China need seldom lose time in first advertising the importance of his wares.

The last decade has seen a large number of students, trained in chemical laboratories in Europe and in America, returning to China fired with a desire to introduce the science of the Occident. Only a very few of these men have, while in this country, received a training or come in contact with influences which fit them specifically to become teachers of chemistry. A large number have been trained in engineering and in chemical research dealing with problems characteristic of America's more complicated industrial fabric. The Chinese industrial world has not yet been educated to the idea of research. There are almost no research laboratories in China and many of these technically trained men have failed to adapt themselves to the simpler but larger problems of Chinese life. The writer was connected with a commission which recently made a survey of chemical education in connection with the American Boxer Indemnity Fund. In one college an American graduate was observed teaching advanced physical chemistry in textbook doses to students who had never performed simple physics and chemistry experiments, and who were in serious need of a course in elementary algebra. Another large university was teaching undergraduates a course in advanced chemical thermodynamics which in subject-matter would have done credit to any graduate school in this country. The students would have profited by a good laboratory course in general chemistry; but the coefficient of digestibility of this course and of the one previously mentioned was exceedingly low. The frantic attempt to suddenly graft into the Chinese educational system the most advanced and the most modern in western chemistry has caused misfits in both teacher and curriculum.

The writer was once called upon to examine a lead-chamber plant which refused to produce sulfuric acid. It had been built from the diagrammatic sketch in a high-school text which accompanied the half-page paragraph on sulfuric acid. Important technical details were, of course, omitted in the sketch. The result was a picturesque expenditure of many hundreds of dollars worth of lead plates but it was a technical failure. Such blundering attempts are sincere, however, and may be but characteristic of a transition stage.

The curriculum of the schools and universities in China is set by the federal government and is under the close supervision of skilled educational

leadership. Six years is the length of the elementary school course of study. This is followed by six years in the middle school. The college course comes after this and is, in general, four years in length This composes the so-called 6–6–4 program of the Chinese educational system. In this, chemistry and the sciences have been given an envied emphasis. The elementary schools give science work about comparable to that of elementary schools in America. The middle school provides the first course in chemistry when the student is about fifteen years old, and if he elects the science course he may follow this with courses in qualitative, quantitative, and organic; all of these would be completed before entering college. The writer visited one middle school not long ago where boys of but fourteen or fifteen were being led through quantitative analysis using one of the standard American college texts. Several of the more youthful members of the class were put to the necessity of standing on laboratory stools every time they wanted to take a burette reading. There are those who doubt the wisdom of so much chemistry in the middle school—*i. e.*, the high school; but it indicates how intense is the desire to bring into the curriculum all those features which represent the scientific method.

For textbooks, college classes in chemistry during the last decade have in very many cases employed texts in English, written and printed in America or Europe. The first chemistry textbook to appear in Chinese was prepared by a Dr. Fryer, a chemist at Shanghai about 1870. It was a remarkable first attempt to use the Chinese language for the expression of chemical concepts. An original chemical vocabulary with new picture-grams was especially invented to make the text possible. This book is now looked upon largely as a linguistic curiosity. The textbook situation in China is linked very closely with the language problem. The language of China is undergoing a genuine renaissance which is rendering it more suitable for use in scientific work and, among other things, a complete system of chemical terminology is being developed. Up to the present, most of the texts in Chinese have been translations of, or compilations from European or American texts. But the Chinese background of applied chemistry is so different from that in the United States; moreover, much of the translation work has been carried out by men who are not teachers. The result has been an accumulation of dictionary-like repositories of foreign chemical information in the Chinese language. That quality of the good text which makes it a student guide to study has been conspicuously absent. The textbooks, which have appeared in Chinese, cover with one or two exceptions the field of general chemistry only. The Chinese schools are very much in need of a chemistry text which will interpret in a scientific way the background peculiar to China and which will be indigenous to Chinese life and thought.

The China Society of Chemical Industry and the Science Society, with

its chemistry section, are the prominent national associations of chemists and chemistry teachers. The Science Society, founded twelve years ago, is the oldest of these. Both organizations publish journals in the Chinese language. In addition to these are other journals of the border-line sciences. At present ten journals in China are abstracted for *Chemical Abstracts*. Most of the Chinese chemists trained abroad retain their membership in Occidental chemical societies.

The desire to put science teaching in China on a sound basis has received substantial stimulus with the organization two years ago of the China Foundation for the Promotion of Education and Culture, which will administer, as invested funds, the remainder of the Boxer Indemnity recently returned by the American Government to China. Science institutes, which in effect are science teacher-training schools, are being held annually and are financed by these funds. The institutes give regular curriculum courses and are able to invite faculty from the principal laboratory teaching centers in China and also prominent scientists from Europe and America. Two annual sessions of this science teachers' college have already been held at Tsinghua University near Peking. Additional funds from this foundation are being used to furnish equipment and to establish additional professorships in institutions which aim to train teachers of chemistry and the other sciences.

This account has not touched upon the contribution which China's philosophic past and her ancient acquaintance with the field of chemistry should enable her to make to world progress and scientific thought. This present phase in Chinese chemical history is essentially a renaissance, a recovery from the last three hundred years of chemical lethargy. The present task of the teacher involves not only the introduction of scientific thought but the simultaneous conservation of the valuable heritage which is characteristically Chinese.

Baking Soda Declared Cold Preventive. That old familiar remedy, baking soda, has found a new use as a preventive for the common cold, Dr. Volney S. Cheney, medical director in one of the large packing firms of Chicago, has reported to the American Public Health Association.

Eleven years spent in an exhaustive study of colds have convinced Dr. Cheney that this too common malady is not infectious, as is commonly believed. The organisms usually regarded as the causative factor in colds are only secondary invaders in the latter stages, he declared.

The primary cause he identified as a condition of mild acidosis that is brought about by too much protein in the diet, lack of exercise, and infections already present anywhere in the body. Dr. Cheney maintained that colds can be prevented and even cured by keeping an alkaline balance in the body through proper diet and carefully regulated doses of sodium bicarbonate or alkaline waters along with small quantities of calcidine and iodine.—*Science Service*

WHAT CHEMISTRY SHOULD EVERY ADULT AMERICAN KNOW?*

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Possibly the title of this paper will meet your challenge at the outset, and you will say that there *is* no chemistry which every adult American should know. Not every adult American, you will say, knows the meaning of the World War, nor who was president of the United States in 1923, to say nothing of the meaning of the most elemental civic functions; hence why expect every American to know something of chemistry? I am entirely willing to qualify the title, so that it shall read: What chemistry should every supposedly intelligent, adult American know? Is there still something to discuss, or is the hope that intelligent people in America will *ever* know the fundamentals of chemistry a vain and fatuous one?

It may be appropriate to ask if every American is getting the *opportunity* to know chemistry, or, to be more concrete, if every child attending high school in this country has the opportunity to study chemistry *now*? We spend a great deal of time making outlines of minimum essentials of high-school chemistry courses, we make similar outlines to standardize the qualifications of intending high-school teachers, and of the equipment of their laboratories and class-rooms, and these are probably necessary pursuits for such organizations as ours; yet we do not realize, apparently, that these enlarged requirements and standardizations are all the while accompanied by a tremendous loss of the students for whom requirements and teachers and laboratories exist.

Let us take a few illustrations. A recent accrediting list of the University of Illinois numbers 631 high schools and academies. Of these only 341, or 54 per cent, offered chemistry at all. This may seem a fair proportion, but what of the number of students actually pursuing chemistry in these schools? I know one of them that enrolls 1800 students in all, and has a graduating class of 250, yet only 35 are studying chemistry. I know another with a total of 1200 students, a graduating class of 205, and only 40 in chemistry—one out of every five of the graduating class. In Chicago, this year, there are reported to be 67,348 students in the high schools and the junior college. The number of students in chemistry is 4400.

However one interprets these figures, the fact remains that not more than a small proportion of the pupils attending our high schools receive any chemical instruction at all. What of the many who do not attend high school? At the rate at which we are working, how soon shall we educate the American people in chemical modes of thinking?

But the stupendous nature of our task and the inadequacy of our dealing

* Paper delivered before the Division of Chemical Education of the A. C. S. at Richmond, Va., April 13, 1927.

with it are, after all, digressions from the main theme of this paper. We are now chiefly concerned with that portion of the high-school or college chemistry course which is carried back, by the one who has pursued it, into his life's thinking. It is the *usable residue*, if any, that we are interested in. What ought every one to remember and use of what he has studied in chemistry? I think we shall agree that the one thing needful, the one objective of all our efforts as teachers, is the development, in the learner, of the *chemical point of view* toward this world of ours and toward our own material life in it. We pray, like the prophet of old: "Open the eyes of the young man, that he may see." First among the essentials of the chemical point of view is that one must have clearly in mind the distinguishing characteristics of *mixtures* and *single* substances. Is it possible, or is it too difficult a task, to leave with our pupil so clean-cut, so deep an impression of this fundamental idea that he will challenge, ever after, all the bodies that come to his notice, until he has satisfied himself of their status in the light of this concept? Is this idea worthwhile in our common living?

I have a story to illustrate how hopelessly impossible is the chemical point of view of the so-called *average* man of today. I was once asked to find out what was the matter with a sample of gasoline. All the automobiles using it had had engine trouble; but when another brand of "gas" was used, the engine trouble ceased. The garage, therefore, cancelled its contract with the first company and the company, in turn, sued the garage for non-fulfilment of contract. It was a simple matter to determine that the offending gasoline was really made up of high-boiling hydrocarbons and that it was incapable of proper vaporization. Then came the trial of the case. The attorneys of neither side knew anything of chemistry, although they were cultivated men. Neither did the jury know enough of chemistry to realize what was going on. Moreover, the attorneys made it practically impossible for me to get the facts before the judge and the jury. I could not talk of substances, of mixtures, of compounds, of properties; for no one present understood these terms. I reduced my chemical vocabulary to words of one syllable, but to no visible effect. At the close of the afternoon the case was continued. That evening, at dinner, chance seated me next the presiding judge. Leaning over to me he asked what was the truth, anyway, about that case of the afternoon. Being uninterrupted by struggling attorneys, I was able to make the situation clear in a few minutes. I verily believe the case was decided upon my informal rather than my formal testimony. If but one or two members of that jury had carried away a few fundamentals from a course in chemistry, there would have been some possibility of an intelligent consideration of the case; but none had.

The truth is that not many of our chemistry students know the differ-

ence, after a short interval, between mixtures and single substances, at any rate not in a clearly defined way. These terms are taught them in too abstruse a language, and with only one or two illustrations, and the course then proceeds to more spectacular material. Yet how can one have the chemical point of view unless he comes to look upon the materials he handles according to the fundamental notion put forward, so long ago, by Lomonossov? If we expect to make the impression deep and lasting, we must do more laboratory and class work to produce the desired effect. The cases studied must not only be numerous, but they must be common cases, and must have in them some of the many complications that one meets with in common, every-day materials. We may not assume that the learner will carry over a single impression, casually made, to other cases that seem to him entirely different.

Our usual study of mixtures is concerned with the separation of iron from sulfur, by means of the magnet and carbon disulfide, before the remainder of the mixture is heated to start the formation of ferrous sulfide. A few of us also separate gluten and starch from flour. Since it is by the use of the idea of mixtures *vs.* single substances that we unravel the complex world about us, the student needs to have this phase of the subject more definitely stressed. He needs actual experience in the examination, by laboratory methods, of a variety of mixtures. One thinks of the following materials as usable; many others will come to mind:

Abrasive soaps, tooth pastes, graphite grease, chewing gum, talcum powders, corn meal, oyster shells, bone, paints (ordinary and metallic), insecticides, flash-light powder, old mortar, gypsum and limestone, soil, mayonnaise dressing, zinc oxide ointments, coal, kerosene, petroleum, iodized salt, natural marble, commercial zinc and iron, match heads, air as a mixture, putty, tap water or well water, grass, milk, baking powders, and the like.

The individual student need by no means separate all these materials, but he should work with several of them and the instructor should set out the others as an exhibition—the original substances and their components beside them—so that the impression may be a lasting one, and the student may thereafter ask himself, when considering a material body that he or someone else wishes to use: What substance is present? Is it mixed with something else? If so, is its behavior due to one of the components or to the other?

I have selected five *usable residues* which the student of first-year chemistry should carry away from his course:

1. The distinguishing characteristics of mixtures and single substances.
2. The meaning of the properties of a substance.
3. Substances react in definite proportions by weight and, if gaseous, also by volume.

4. Chemical change is a transposition of elements and energy already existing.

5. Chemistry is at the foundation of our modern, material life.

The first of these has been discussed; much that is implied in the second has already come, incidentally, into this discussion. The meaning and validity of what we call the *properties* of a body needs more elucidation in our classes than we usually give to it. In the gasoline case the attorneys kept on talking about the "properties" of gasoline, when they really meant its components or constituents. But aside from the technical definition of terms, the validity of properties in the separation and identification of substances needs to be known more clearly. Pupils need to understand that it is only by the testimony of *several* properties that we decide upon the identity of a body. This fact can be imprinted as a clear concept only by reiteration and renewed acquaintance. How few students of elementary chemistry ever determine a melting point, and yet this furnishes one of the definite properties of a pure body. How glibly instructors and texts talk of density, yet how slowly the idea of density percolates into the minds of our students! We spend considerable time, at the *beginning* of our courses, upon the differences between *physical* and *chemical* properties. The student, having no experience with the nature of the changes involved in the discovery of properties, treats the illustrations as mere memory work. All this time, and more yet, should, in the speaker's opinion, be spent in the laboratory, in the *determination* of properties, as, for example, the density, melting point, boiling point, decomposability, solubility, liquefiability of some pure bodies. In due time the difference between physical and chemical properties will appear, and in a natural way. To define a chemical property according to our common practice as one which can only be manifested by the destruction of the material at hand, in a chemical change, is about as satisfactory to a beginner as to tell him that the best method of distinguishing a mushroom from a toadstool is to eat it. If one dies, it is a toadstool; if not, it is a mushroom.

The third of the five theses already stated deals with definiteness of composition and definiteness of the amounts of reacting materials. This fundamental idea, like the others, needs to be amplified by more intensive effort. To be a real benefactor of instructors and students of chemistry some one ought to devise more appropriate, and especially more convincing experiments dealing with definiteness of weight between reacting materials. No instructor who each year faces the results of such work in the ordinary beginner's class feels very proud of the outcome. The only justification for such experiments lies in the "grand average" of the results of all the class. For the individual results he can only apologize. If our automobile, when on trial, performed as heinously as our elements do when we want them to show off their real, numerical relations, few cars would find their

way into an owner's family group. The truth is that we are expecting students all the while to take the numerical relations of the elements mostly on faith. Nowhere does the ancients' idea of the futility of experiment find so great a justification as in the results of much of our beginning "quantitative" laboratory work, yet we must find a way to get the faith in this definiteness into the chemical point of view which we give our students and the public. One thinks of the quantitative relation between the weight of the coal and the air supply needed to burn it properly as an excellent, common illustration of definite proportions; equally good are the relations between the gas supply and air supply of the gas stove and Bunsen burner, and the gasoline and air supplies of automobile engines. The amounts of gas and air used in a Bunsen burner may actually need to be demonstrated, in order that the idea of volume relation may be fixed clearly.

My *fourth* thesis is that one of the usable residues which should remain from a beginning chemistry course is that nature never gives something for nothing, or to put it in more usual form, every chemical change is really only a rearrangement of materials and a redistribution of energy. As is to be expected, the public is more ready to believe in the conservation of matter than in the conservation of energy. A year ago I was returning from the Tulsa meeting and was seated beside a gentleman who had every appearance of breeding, and who "talked sense" until he came to the question of future supplies of energy. "You can't tell me," he declared, "that we are going to need to worry about supplies of coal, or petroleum, or natural gas, for our power! The chemists are going to provide it."

"How," asked I, "are they going to provide it?"

"Why they'll get it out of the air, out of nothing! You can't tell me!" And then I knew that I was talking to a chemical madman. Surely here was faith without works, in an abundant supply. But my friend of the train was not the only one who that day believed in something out of nothing. That little idea is worth fabulous sums to those who have a little science and a convincing way. The pity is that the poor public has mended its ways too drastically. Instead of believing *nothing* of what the chemist told, the public is now ready to believe *anything*. Thus far the popularization of chemistry has produced in the popular mind chiefly a belief in its jugglery and its mystic power to do the impossible. It ought to be the concern of some one to utilize this enthusiasm of the public and to turn it into chemically sound channels. Surely it ought to be possible to make the mystery of coal tar interesting as a piece of constructive recovery of precious compounds out of compounds already in the tar, and not simply as a conjuror's trick.

The *fifth* result that should remain from a chemistry course is the enlightened conviction that chemistry is at the foundation of modern material life. But if you want evidence of the lack of enlightenment in this con-

viction, ask any chemistry class to tell you the real service of chemistry to modern civilization. The list of benefits will be necessarily meager and distorted. Most prominent will be explosives to be used in warfare, but there will be little or no notion as to how the explosion comes about. Some one may answer: aniline dyes, but there will be no idea of how the aniline comes out of tar or what a dye really is. Students are generally disappointed at seeing pure aniline. It does not look at all like the dye they have always been told about. And so on throughout the list of the service of chemistry to civilization. It is not an easy task to point out the facts so that the enthusiasm of our hearers may be maintained and truth prevail at the same time. The many charts showing the derivation of refined products from crudes, and especially the reaction by which these changes are brought about, are most stimulating. Why would it not be worth our while to take up with each class the preparation of a chart showing the relation of chemistry to our modern material life? What an imposing, convincing list it really is! What pride it gives us, in spite of many disappointments, to realize the importance of the work in which we are engaged. If we go about the matter sanely, how worthy we can make our profession seem to at least the majority of our students.

This paper has said nothing about the theories of chemistry, nor about atomic weights, nor equations, nor electrons, nor a thousand other things that we want, and rightly, in a course of modern chemistry. My apology is that I have been speaking of *usable residues*, impressions which shall be left over and shall influence points of view and ways of action long after most of the detail of chemistry has been dimmed by time. It is these details and embellishments that *aid* in producing the permanent results, if there are any, and which justify chemical study for the real chemist. I have not argued against these details, but in favor of the larger, more usable point of view for the bulk of mankind. "These things we ought to have done, and not to have left the other undone."

Parasite Causes Change in Chemistry of Sex. Edging a male animal over toward becoming a female without actually changing his sex, is the feat accomplished by a parasite that preys upon a certain species of crab, according to a British scientist, Michael Perkins of Cambridge, who writes of his discovery in the scientific journal, *Nature*.

Mr. Perkins had noted that some of the male crabs attacked by the parasite changed their appearance, coming to resemble females. He made chemical analyses of these crabs, using the methods devised by Manoilov and other biochemists. He uniformly got the color-changes indicating femaleness, although the animals were still functionally males. Further tests on parasitized males that had not changed their body-form showed that the chemical change indicating femaleness had nevertheless taken place.

The British worker is not inclined to regard the chemical tests as positively indicative of sex in any case, but rather as of a chemical condition that is usually, but not necessarily invariably, correlated with sex.—*Science Service*

JOHN RICHARDSON YOUNG, A PIONEER PHYSIOLOGICAL CHEMIST

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John Richardson Young, a pioneer physiological chemist and physician, was born at Elizabethtown (now Hagerstown), Maryland, about 1782. His father, Samuel Young, M.D., was of Irish birth and was a graduate of Trinity College, Dublin, and of the medical department of Edinburgh University. His mother was Ann Richardson, who died at the age of 31.

John Young must have been a very precocious boy, for he graduated at Princeton in 1799 when he was about seventeen years of age. Immediately after leaving college he began the study of medicine with his father who was a successful physician at Hagerstown. In November, 1802, he entered the medical department of the University of Pennsylvania and graduated in June, 1803, with the thesis entitled "An Experimental Inquiry into the Principles of Nutrition and the Digestive Processes." One of his medical instructors was another distinguished son of Old Nassau, namely, Dr. Benjamin Rush of the class of 1760. According to Dr. Howard A. Kelly, "Benjamin Rush was easily the master mind in medicine in his day, and his title to be called the modern Hippocrates, and the American Sydenham, was hardly then disputed."

Young's instructor in chemistry was Dr. James Woodhouse, a contemporary of Joseph Priestley, John Maclean, and Samuel Mitchell.

Dr. Young's claim to fame rests largely upon his medical thesis. According to Dr. C. F. Langworthy of the Bureau of Home Economics, United States Department of Agriculture, Young was the first American scientist to make a definite attempt to study the chemistry of food and nutrition experimentally. Dr. Langworthy says: "On receiving his medical degree Young returned to Hagerstown and joined his father in the practice of medicine. His death from tuberculosis occurred there very soon after. Doubtless, owing to the fact that his thesis, like others of the time, was not widely distributed and probably also to the fact that he died so soon after graduation, his work was apparently completely forgotten until it was found again in 1908, in connection with some bibliographical studies made in connection with nutrition work of the U. S. Department of Agriculture."

To appreciate the importance of his pioneer work in physiological chemistry, it is necessary to know something about the early notions concerning digestion. An excellent general review is given in Dr. Howard A. Kelly's paper on Dr. Young, which was read before The Johns Hopkins Historical Club, April 8, 1918.[1] We owe much of our information concerning Young to Dr. Kelly.

[1] *The Johns Hopkins Hospital Bulletin*, **29**, No. 330, August, 1918.

Digestion, according to the *animistic* doctrine, is due to a mysterious spirit which resides in the living organism.

Others claimed that digestion is *mechanistic;* that the work is done by trituration and attrition, as in the stomachs of grain-eating birds. According to another view, digestion is a sort of *putrefaction.* This view appeared to be more plausible after the notion of *fermentation* was advanced.

Others considered digestion a simple process of *solution.*

In the study of the problem of digestion, Dr. Young introduced the modern laboratory or experimental method; indeed, he was the first American medical man effectively to employ this method. He experimented on frogs, snakes, lizards, etc., as well as on man.

In certain experiments the common large bull-frog was chosen in order to observe the effects of the gastric fluid, because it swallows its prey whole and has a very wide æsophagus, thus making it easy to empty its stomach by means of forceps. In one case he observed that a small spring frog was digested without "any acid or putrid smell." He also observed that the gastric fluid spared neither bones nor teeth, showing that it is a powerful solvent.

As stated in his thesis:

> Being desirous of knowing the length of time they would require to dissolve down a small frog, the following experiment was performed. A packthread was tied to the hind legs of a living spring frog; its head was then put into the mouth of one of the large frogs; as soon as he felt it move it was swallowed greedily. In five hours it was drawn up by means of the thread; the skin and external surface of the muscles were tender. It was again introduced; in the space of seven hours, it was drawn up a second time; the adbominal muscles were now dissolved, and the intestines had protruded; the bones of the feet were soft, and separable from the leg by the least force; in a word, the whole was a complete dissolved mass. It was swallowed a third time, and attempted to be drawn up in six hours afterwards; but it had so far lost its texture that the two legs, to which the thread was tied, could only be brought up; the bones of these were soft and flexible, as before mentioned. Many experiments of this kind were made to see the effects of their gastric menstruum; in many cases, after giving them small frogs, the trunk and head of these animals were drawn out of their stomachs complete skeletons, but the bones were always soft, and felt like tender cartilage. In all the half-digested substances which were at different times taken from their stomachs, as frogs, veal, beef, etc., an acid was constantly found present; they were seldom examined before two hours after being swallowed; at this short interval when their surfaces were touched with litmus paper, it was turned red.....
>
> The gastric fluid of man and that of frogs and snakes agree perfectly in their action on flesh, as the experiments of Spallanzani prove that the first of these powerfully dissolves meat out of the body. As the menstruums of the two latter animals acted so uniformly on bones, it appeared highly probable the fluid of our own stomach would also. To ascertain this, the condyles of the thigh bone of a chicken, weighing eleven grains, were swallowed; the bone remained a considerable time in the stomach, as was supposed from some uneasy sensations that were occasionally experienced for between two and three days; the fourth day it was discharged, reduced to a shell, weighing only three grains. Thus far the digestion of man and these animals perfectly agree, in solution

being the first step towards the conversion of food into chyle; but they differ in some particulars, and probably by attending to these, they may be of use to us.

First. They are cold-blooded animals: heat is a powerful agent in all solutions, and the experiments of Spallanzani prove it greatly assists the action of the gastric liquor out of the stomach.

Secondly. They do not masticate their food.

These two inconveniences are obviated, by these animals never drinking when their digestion is going on, so that their fluid acts in its undiluted state; whereas in man, it is always diluted, as he seldom eats without drinking. That this was the case with these animals I had clear proof; for although I examined the contents of their stomachs so often, in no case could I find any fluid more than a jelly-like substance, appearing to be made up of gastric juice and dissolved flesh. Supposing, however, that the pressure used in bringing up the food of the frogs might have forced the more fluid parts into the duodenum, I resolved to ascertain the fact in another way; this was easily done. A teaspoon could readily be passed into their stomachs, and with this the dissolved food could all be brought up; it was always, however, of the consistence above mentioned. During the time these experiments were made, they were constantly kept in large jars of water. The attention to this circumstance by these animals, which swallow their prey entire, is a necessary part in their digestion, as they require a very powerful menstruum, so as to dissolve not only entire muscles, but also bones. The inference we would draw from it would be, to attend occasionally to what necessity urges them to observe constantly. Thus when our stomachs are weak, or we are troubled with dyspeptic symptoms, like them we ought to avoid much diluting of our gastric juice; so that although it were secreted not perfectly healthy, yet having the advantage of acting in its uncombined state, solution and digestion may go on, when it otherwise would not with the common quantity of drink. Indeed our stomachs in this respect act a kind part to us; for when we make our first dish on broth it seldom relishes much solid aliment after it; hence soups are the first dish at the table of the temperate, and the last at that of the epicure.....

Young also put peas, beans, wheat, and bread (in a bag) into a frog's stomach and observed that even after thirty hours there was not the least change in the peas, beans, and wheat, but the bread-bag was empty, showing that the bread had been digested. He then ground up the peas, beans, and wheat, and noted that they were digested.

Dr. Young then took up the question of *fermentation* in the stomach. He says:

Chemists divide fermentation into three kinds, the vinous, acetous, and putrefactive; the product of the first is vinous spirit, or alcohol; of the second, acetous acid, or vinegar; of the third, ammoniac, or volatile alkali.

In order to ascertain whether a vinous fermentation could take place in the human stomach the following experiment was performed. My friend, Mr. Mitchell, avoided his usual breakfast, in the place of which he took, between the hours of eight and ten, twelve ounces of sugar. Nothing more was taken until one o'clock. Having the power to ruminate, it was at this hour thrown up; the mass was sweet; upon being put to test no intestine motion or disengagement of air was to be perceived. It was then submitted to distillation: a limpid fluid passed over into the receiver, which was sweetish, but had none of the properties of a vinous spirit. Carbonic acid gas is constantly evolved during the vinous fermentation; Mr. Mitchell therefore paid particular attention to this, as long as the sugar was on his stomach; but there was not the least eructa-

tion of air during the whole period the experiment was going on. If ever a vinous fermentation took place in the stomach, we expected to have found it in this experiment; as this viscous was plentifully supplied with saccharine matter, which passes so readily to this state; but as nothing of the kind occurred we conclude the vinous fermentation has nothing to do with the digestive process.

Furthermore, he says:

On an empty stomach, I made a light dinner, on chicken pye, and drank simple water; in half an hour, by irritating my fauces, it was thrown up; at this time it was plentifully supplied with gastric fluid, as well as saliva, as the quantity of food was but small. It was then exposed in a tumbler to a heat equal to the human temperature. For the space of nine hours there was not the least intestine motion nor any disengagement of air. As digestion is performed sooner than this period, it was not attended to any longer.

He knew that there was acid in the stomach, but erroneously thought it was phosphoric acid. In one experiment he held hydrochloric acid in his hand, but unfortunately failed to identify it.

He tells us that the Italian anatomist Morgani is responsible for the following extraordinary story:

He (Morgani) informs us that a young lady living entirely on vegetables (it being Lent), was seized with a violent affection of her stomach, and great emaciation ensued. Different medicines were used, but without the least alleviation of her symptoms. At length a violent vomiting commenced, and to the astonishment of all present, she threw up a small plant, with perfect leaves and roots! This at first sight might be looked upon as approaching the marvellous; yet why should we doubt it. The authority of our author is as respectable as any other of our profession; and we have seen that seeds will vegetate when retained a sufficient length of time in the stomach. The probability here was, that the young lady had swallowed the seed of some small plant, without destroying its texture by mastication; which being retained in the stomach, and exposed to heat and moisture, vegetation progressed.

It occurred to Dr. Young that calculi of the bladder might be dissolved by the fluid of the frog's stomach, as told in the following words:

A calculus was obtained from Dr. Jacobs of a very firm texture weighing exactly fifty grains. It was introduced into the stomach of one of the large frogs. In two days it was taken out for examination; at first sight it was evident solution had taken place, for the gastric juice which adhered to it was coloured with some of the dissolved stone: it was found to weigh forty-five grains. It was forced into the stomach a second time, where it remained for two days; it now weighed thirty-eight grains; from this, it appears it is well worthy of more attention. When introduced into the bladder, with the heat of the human body, we have little doubt the gastric juice of frogs would act upon calculi with much effect. The fluid is easily procured, and without the necessity, as in other animals, of sacrificing a life every time we wish to obtain it; by means of a teaspoon it is readily brought up from their stomachs.

His explanation of digestion was expressed in the following words: "We would therefore explain this process in a few words. Aliment is dissolved by the gastric menstruum; it then passes into the duodenum and

meets bile and pancreatic liquor; after being united with these, a heterogeneous mass is formed called chyme, and from this the lacteals secrete chyle."

According to Dr. Kelly, "Young was the very first American medical man to enter the new field of fruitful experimentation, and to bring home his own sheaf for the garner." He has well summarized Young's achievements as follows:

(1) He did away with the theories of innate heat and vital spirits as the essential factors in the act.

(2) He did away with the notion that digestion was essentially a process of trituration, fermentation, or putrefaction.

(3) He showed that it was effected by an acid which he attempted to analyze, and concluded that it was phosphoric acid.

(4) He experimented on animals and on men (himself and a friend).

(5) He secured pure gastric juice and experimented with it *in vitro*.

(6) He showed that the acid gastric juice checked putrefaction.

(7) He drew the inference that dyspeptics ought not to dilute the gastric juice with water.

Dr. Young was one of the founders of the American Linnean Society and was a member of the Philadelphia Medical Society.

His grave is in the old St. John's Churchyard, Hagerstown, Md., and his simple tombstone is inscribed as follows:

IN MEMORY
OF
JOHN R. YOUNG, M.D.
WHO DEPARTED THIS LIFE
ON THE 8TH DAY OF JUNE 1804
IN THE 22D YEAR OF HIS AGE

"*Nec prosunt domino quae prosunt omnibus artes*"

Pause stranger on this sacred spot
Here give to worth a parting sigh
So may thy grave be ne'er forgot
When the lorn stranger passes by.

It is interesting to know that his father died in 1838, at the age of 108, as attested by his tombstone.

The following bibliography is taken from Dr. Kelly's paper, which was previously mentioned.

John R. Young's Writings

1. An experimental inquiry into the principles of nutrition, and the digestive process. Philadelphia, 1803. Printed for the author by Eaken and Mecum. 48 pp. Also in: Caldwell's Medical Theses (etc.). Philadelphia, **1805,** 1, 275–298.

2. Case of tetanus cured by mercury.... *Phila. M. and Phys. J.*, **1804,** I, Pt. 1, 47–51.

3. (Use of) Saccharum saturni in three cases of uterine haemorrhage (extract from letter dated Hagerstown, March 29, 1804). *Phila. M. and Phys., J.* **1804,** I, Pt. 1, 145.

4. Manuscript on the process of digestion. Without title-page (not published).

Strange "Element" Believed Due to Common Gases. Nebulium, the strange "element" that has been supposed to exist in such bodies as the great cloud of glowing gas in the star group of Orion, seems to be nothing but oxygen and nitrogen, of which we take in about a pint every time we breathe. This is the opinion of I. S. Bowen, of the Norman Bridge Laboratory of Physics at Pasadena.

Following the discovery of helium, first as a strange line in the spectrum of the sun, and then as an actual element on the earth, a mysterious group of lines was found in the spectrum of some of the nebulae. As most of the spectral lines are known to be due to certain elements, it was thought that the strange lines, of which one was green, might be due to an element as yet undiscovered.

Dr. Bowen's studies now indicate, however, that these lines are due at least partly to oxygen and nitrogen, of which the air is chiefly composed, but in what is termed the "metastable state." While in the laboratory atoms of certain gases can be induced to enter this state, they ordinarily return to the normal condition without giving off light, by bumping into other atoms or the walls of the tube. In the nebula, however, the pressure is very low, probably much lower than the lowest terrestrial vacuum, which means that the atoms are not so crowded. They are, therefore, less apt to bump into each other, and the walls of the tube are absent. The result is that the atoms remain longer in the metastable state and finally return to the normal condition spontaneously. According to Dr. Bowen's calculations, if this happened, light would be given off of the same wave-lengths as the mysterious, nebulium lines.

Dr. Bowen reported his conclusions recently to the British scientific magazine, *Nature*. In a later issue, Prof. A. Fowler, a leading English authority on the subject, states that the evidence, on the whole, "appears to be in favor of Mr. Bowen's suggestions." He also suggests that one of the lines, in the part of the spectrum just beyond the red end, should be accompanied by a fainter line on the side toward the visible spectrum. If astronomers can discover this in the spectrum photographs of the nebulae, it would be strong evidence in favor of Dr. Bowen's views.—*Science Service*

Jerusalem Sulfur Fog May Have Come from Dead Sea. Burning sulfur deposits on the shores of the Dead Sea may have been responsible for the strange luminous fog that swept over Jerusalem a few nights ago and caused a two-hour period of choking discomfort to the inhabitants. This opinion was hazarded by Dr. Immanuel Friedlaender, a noted European student of volcanic phenomena, founder and director of the Volcanological Institute at Naples.

There is little likelihood of the sulfurous mist having come from a volcanic source Dr. Friedlaender stated, for though the region was once volcanic there have been no eruptions within historic time. However, there are large exposed deposits of sulfur around the Dead Sea, which have long been pointed out as part of the brimstone from heaven that destroyed Sodom and Gomorrah. Since Jerusalem is only about fifteen miles west from the northern end of this great salt lake, a fire accidentally started on the sulfur beds when the wind was blowing toward the city could easily give rise to fumes of sufficient strength to be distinctly disagreeable to its inhabitants.—*Science Service*

A COMPARISON OF CONTENT AND ACCOMPLISHMENT IN CHEMISTRY OF STUDENTS IN ENGLISH AND AMERICAN SECONDARY SCHOOLS

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The effectiveness of instruction in secondary schools of England has been for sometime a subject for conjecture. American observers have recognized that the organization of curricula and methods of instruction differ considerably from that of their own schools and many have reported from their observations that the work is effectively done. It has, therefore, seemed appropriate to apply some objective measures of accomplishment and thus secure an objective basis for comparing the effectiveness of instruction in English and American schools. Chemistry has seemed an appropriate field in which to apply these measures, for although the organization and methods of instruction are in some particulars quite different, the content which is covered seems closely similar and this subject is given a rather prominent place in the secondary schools of both countries.

Information concerning content of instruction in England has been gathered through study of textbooks and syllabi, and from correspondence with the coöperating teachers. The data which constitute the basis for the comparison of accomplishment have been gathered by application of the Powers Chemistry Test (Form A)[1] and the Gerry Chemistry Test (Form A)[2] to each of 258 students studying chemistry in ten secondary schools in and about London. These tests required about two hours work from each student. They were administered in July, 1926. In December, 1926, the Terman Group Test of Mental Ability was administered to students in the same schools and of the same grade level as those who took the chemistry tests. The achievement measures and intelligence measures were not administered to the same students.[3]

[1] Published by World Book Company, Yonkers, N. Y.

[2] Published by Harvard University Press, Cambridge, Massachusetts.

[3] This comparison has been made possible by the cordial coöperation of Mr. G. H. J. Adlam of the City of London School, Editor of *The School Science Review*, and other teachers who are members of The Science Masters Association of England. I am especially indebted to the following teachers for administering the tests and for furnishing in correspondence much useful information relating to the interpretation of results: W. R. Ray, Lower School of Lawrence Sheriff, Rugby, Warwickshire; E. Graham Laws, The Grammar School, Leeds; T. J. Baker, King Edward's School, Birmingham; W. Cammack, George Green's School, London; E. H. Nelthorpe, Erith County School, Kent; G. S. Stones, Erith County School, Kent; J. Howard Brown, Lord Williams' School, Thame; G. F. Hood, Nottingham High School, Nottingham; F. Wootton, Ashford County School, Middlesex; F. A. Beesley, St. Olave's School, London; F. W. Turner, Harrow County School, Middlesex.

The Program of Instruction in English Schools

Proper interpretation of the results requires some attention to the types of schools in which tests were given and to other factors which affect the content of the course and the aims and methods of instruction. In the first place there are three varieties of secondary schools and in these there are considerable differences in practices.

1. The great public schools like Eton, Harrow, and Rugby, entirely for boarders and charging high fees. The curriculum is mainly classical and humanistic. There has been an increasing offering of science in these during the period of the last few decades. No tests were given in these schools.

2. The "Grammar Schools" charging moderate fees, often small in size and situated in small country towns. In these as much attention is given to science and mathematics as to languages. The curriculum of the Grammar School type corresponds most closely to that of the academic preparatory curriculum of American schools.

3. The new "council" or "county schools," established since 1900, often very large and situated usually in thickly populated areas or industrial towns. Fees are small and in a very few areas no fees are charged. The curriculum has a modern scientific bias and boys pass largely into business. Chemistry is taught to a certain extent for its industrial applications.

The competitive examinations seem to be the most effective standardizing agencies for the chemistry course in the English schools. The examinations for which the students are prepared are:

1. School Certificate Examination. This is apparently a general term which includes the Senior Oxford, Cambridge Local, or London Matriculation or other university entrance examinations recognized and approved by the School Examination Council of the Board of Education. Candidates are about 16 years of age and have had from 200 to 250 hours of instruction in chemistry.

2. Higher School Certificate Examination. An illustration of this is the Intermediate Science Examination conducted by the University of London. Candidates are about 18 or 19 years of age.

For the most part the tests were given to students who were nearly ready for the School Certificate Examination. The period of instruction in chemistry of the students who enter this examination varies somewhat but is nearly the same as that of American students at the time of completion of the one-year high-school course. They are, however, somewhat more than one year younger. The total content of the courses in chemistry in the two school systems appears to be nearly the same. There are, however, some notable differences (1) in the manner in which the time

for instruction is distributed, (2) in the order of presentation of subject-matter, (3) in the aims and objectives of the course, and (4) in the methods of instruction. Interpretation of the test results requires some attention to these points.

1. **The Time Distribution.**—In American schools the work in chemistry is given as a one-year course consisting of about 200 hours of instruction and it is given in either the eleventh or twelfth grade. The age of those taking it is about 16 or 17 years. In English schools the work is distributed over several years. In Lord William's School at Thame, for example, chemistry is begun at age $12^1/_2$, with 15 periods of instruction during one term of the year. It is continued through the three terms of the next year with a total of 45 periods. During the third year there are 45 periods and during the fourth 120 periods. This is a total of 225 periods. The School Certificate Examination regularly follows this period of instruction.

In King Edward's School, Birmingham, boys begin chemistry at about the age of 13 or 14 and have one period per week for the first year, two weekly periods during the second, three during the third, and four during the fourth year.

These illustrations show the general tendency of English secondary schools to distribute over a period of two, three, or more years an amount of instruction in chemistry which is comparable to that given in American schools in one year.

2. **Instructional Material Texts.**—English schools use a series of small textbooks of gradually increasing difficulty rather than one book of approximately uniform standard throughout. Some teachers report that they use no text in the earlier years of the course.

3. **Aims and Methods.**—In correspondence with the coöperating teachers, and in the printed matter which is descriptive of their courses, frequent reference is made to the fact that the aim of instruction is to develop an understanding of the scientific method. There is little emphasis on practical applications and the method is largely heuristic.

The only available professional book of recent issue on science teaching[4] comments that with well-trained teachers the syllabus may safely be left in their hands and detailed study of the practices in the coöperating schools suggests the conclusion that this practice is followed, at least to a much greater extent than in the United States. There are, however, in addition to examinations some more or less effective standardizing agencies. In 1905 the Incorporated Association of Head Masters issued a "Syllabus of an Elementary Course in Physics and Chemistry." Descriptions of courses which came in correspondence from the

[4] John Brown, "Teaching Science in the Schools," University of London Press, 1925.

coöperating schools suggest that the content of the courses in these schools is patterned at least in some measure from the brief suggested outline which is contained in this syllabus. In this it is stated, "All formulae and equations, all ideas of molecules and atomic weights are avoided in this course, and chemical names are only introduced in proportion as their meaning can be established." The major purpose of the course is suggested by the statement that, "While the main object of the course should be to train students to solve simple problems by experiment—to work accurately and with a clearly defined purpose, and to reason from observation—the instruction given should eventually lead them to comprehend the nature of air, fire, earth and food." The extent to which the heuristic method predominates practices is suggested by the following recommendation for teaching procedure:

> It having been previously observed that when metals such as iron and zinc dissolve in acid a gas is given off which burns, this gas should now be studied with the object of finding out what happens when it burns. Having ascertained that it affords a liquid when burnt they should have compared this liquid with water—which it resembles in obvious properties—by ascertaining its density, freezing point, and boiling point. Having thus discovered that water is formed on burning the gas in question they should have been led to discover that oxygen is also concerned in its formation, and to produce it from oxides such as those of lead and copper. They should then have made quantitative experiments from which they could infer the composition of water by weight. The properties of water should have been contrasted with those of its components, and the production of heat as a consequence of the association of the two gases and in other cases of association consequent on and attending burning, should have been thoroughly grasped—in fact, at this stage, a full general understanding of the nature of combustion should have been arrived at, and the evolution of a definite amount of heat, as the consequence of the formation of a definite amount of the compound substance, should have been made thoroughly clear to them.

This quotation reveals that teaching methods are in some respects quite different from those which prevail in the United States. American teachers could not be persuaded to allow as much time for the study of the composition of water as would be required for the heuristic development suggested in the above quotation.

The laws and theories of chemistry, including the laws of Boyle and of Charles, Law of Constant Proportions, Atomic and Molecular Theories, etc., which are given a place of prominence in courses in American schools have no place in this elementary syllabus. However, these are included before students sit for the School Certificate Examination.

In the Report on Science Teaching in Secondary Schools is a "Scheme of Science Work for an Urban Secondary School for Boys."[5] This is a four-year course for boys of ages twelve to sixteen. "In this the work of

[5] T. Percy Nunn, "Scheme of Science Work for an Urban Secondary School for Boys." Report on Science Teaching in Secondary Schools, British Association for the Advancement of Science, **1917**, pp. 160–172.

each year is divided into two sections—biological and physical. The proportion of time assigned to biology decreases from more than half in the first year to a fifth or less in the last year, with a corresponding increase in the relative importance of the physical section. It is assumed that five hours a week are assigned to science teaching in each year." No chemistry is outlined for the work of the first year but it is included in the outline for each of the succeeding years. In this outline it is stated that the course is intended to throw into clear relief the fundamental ideas and results of science, and to give the pupil a real, if rudimentary, acquaintance with the true character of scientific inquiry. "To attain these ends the work will often be 'heuristic' in character and as often take the form of lecture-discussions between teacher and class, preceded, accompanied, and followed by experimental work."

The work of the first year in chemistry seems to be directed toward the acquisition of an acquaintance with chemical materials and chemical phenomena. The laws and theories of chemistry are not introduced during the first year but are introduced into the work of each of the two succeeding years. The total content which is outlined in this course is about the same general field as is covered in the one-year course in American secondary schools. The order in which the material is presented, however, differs considerably.

The Test Results

The instructions to the coöperating teachers were that the tests should be given to pupils who had completed approximately 250 hours of instruction. This period of time is a little greater than that which is given in the one-year course in American schools. For the most part the tests were administered just before the students sat for the matriculation or school certificate examination. As has already been suggested, the period of preparatory instruction for this examination varied considerably in different schools. A fairly homogeneous grouping was made by bringing together the scores of those whose period of instruction ranged from 176 to 250 hours. For most of these, the period approximated 215 hours.

The Mental Ability Test.—Evidence that this grouping has brought together the scores of a fairly homogeneous group is revealed by reference to the Mental Ability measures. These are shown on the chart (Fig. 1) in comparison with the author's norms and in comparison with the scores of children in the eleventh and twelfth grades of an American public school and an American private school. Comparisons may be readily drawn by reading the scores on the axis of ordinates and percentiles on the axis of abscissae. For example, the author's norms for the test shows that the scores of twenty-five per cent of the American students were higher than 170, whereas the scores of sixty per cent of the English stu-

dents were higher than 170. The lowest mean intelligence score of any of the English schools is 152.5 and the highest is 182.5. The mean for the entire group is 169.58.

The author's norm for the test for the twelfth grade is 147. Ninety per cent of the scores of the English students are higher than the forty-fifth percentile score of the author's norms. Seventy-five per cent were higher than the sixty-fifth percentile of the author's norms. The median ability score of students in chemistry in a large American public school is just twenty points lower than that of the English students taken collectively. The median score of the eleventh- and twelfth-grade students in an American private school is 186 which is twelve points higher than the median score of the English students. The median age of the American children was about 17 years. In two other private schools the medians for the twelfth-grade class were 177 and 178. The median ages of these were 17 years, 3 months and 17 years, 2 months. The mean score of 23 children of mean age 15.8 years in one of the English schools is 182.5. This is higher than any mental ability scores which have been reported in America from children of this age level. The mean score from another school of 43 cases of mean age 15.5 is 172.7. The mean age of the entire group of English children who took the test is 15.78 years. The median age of the twelfth-grade children from which the author's norms were computed is 18 years. This is more than two years above the age of the English children of the coöperating schools. If any allowance is made for the fact that the test was made in America and that the English children worked somewhat at a disadvantage, it must be concluded that the ability of the children in all the schools in

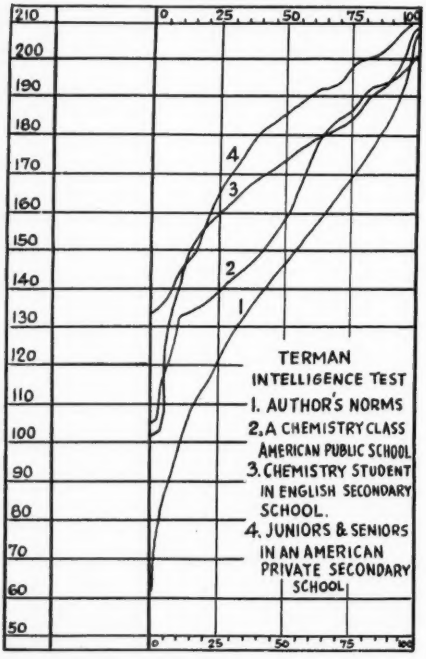

FIG. 1.—Percentile distributions of scores on Terman Intelligence Test (Test of Mental Ability).

which the tests were used is equal if not superior to that of students in our most select private schools and greatly superior to that of students in our public schools.

The mean Terman scores together with the mean age and range of ages of the student who took the tests in each of the schools is shown in the following tabulation.

TABLE I

MEAN TERMAN SCORES AND AGES

School	Terman mean	Age mean	Age range	Cases
1	177.3	16.4	15–18	31
2	164.5	16.0	15–18	24
3	172.7	15.5	14–18	43
4	153.4	15.8	14–18	29
5	182.5	15.9	14–19	23
6	152.5	15.0	14–16	21
7	164.0	15.8	14–18	24
8	169.0	16.3	14–19	32
9	173.1	15.8	14–18	21
All	169.58	15.8	14–19	253

Direct comparison of the data in the table may be made with the following norms for American children: (*a*) Terman Test norm for twelfth grade students (median) 147; (*b*) Age norms (1200 cases) for students at time of completion of course in chemistry, 17 years, 3 months; (*c*) Age norms for twelfth grade students studying chemistry, 18 years.

The Chemistry Tests.—The Chemistry tests have been used rather extensively in the United States and valid norms are available. The record chart (Fig. 2) shows the distribution of scores made by the English students and it shows a comparison of this distribution with that of the author's norms and with the scores from selected schools. The scores on the Powers Test of the group which had taken from 175–250 hours of instruction (111 cases) is uniformly lower than the author's norms. The 288 to 388 hour group (78 cases) is somewhat though not markedly higher. More than ninety per cent of the scores from the American School with the highest median are higher than the ninetieth percentile of the English group of 175 to 250 hours' instruction and approximately seventy-five per cent are higher than the ninetieth percentile of the English group with the larger period of instruction. The range of the mean scores for the different schools is from 22.5 to 38 for the first group. The scores of the group on the Gerry test are somewhat higher than the author's norms but the scores of neither group are as high as the scores of the American public school (Fig. 2). The range of the mean scores of the five schools of the first group is from 7.9 to 16.6. The mean of one of the schools equalled the mean of the American school. The range of the means of

the seven schools of the second group is from 12.7 to 17.5. Three of these schools were higher than the American public school but in two of these the number of cases is so small that the scores are not significant.

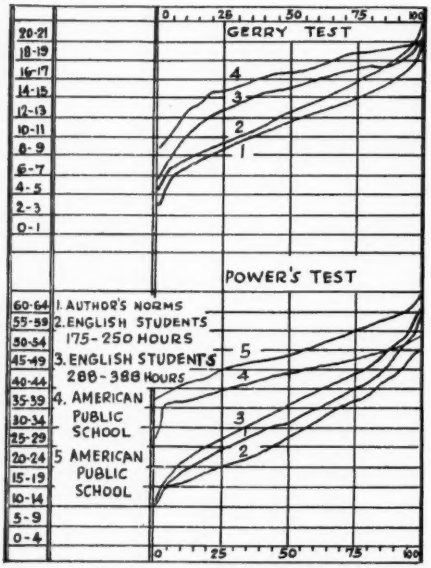

FIG. 2.—Percentile distributions of scores on Gerry's Tests of High-School Chemistry and on Powers' Test of High-School Chemistry.

The means of the scores on both tests and ages together with the hours of instruction in chemistry for each group is shown in the table.

Detailed analysis of the test results reveals that there were some items on which the percentage of the responses which are correct was greatly different from the author's norms. The results reveal an evident lack of emphasis on some of the applications of chemistry. Test items relating to the etching of glass, composition of cotton fiber, bleaching, composition of foods, source of commercial oxygen, chemistry of blue-printing, purification of water and mining of sulfur are illustrations of items which were markedly more difficult than

TABLE II

MEANS OF SCORES ON GERRY AND POWERS TESTS

School	81–117 instruction hours Gerry	Powers	Cases	176–250 instruction hours Gerry	Powers	Cases	288–388 instruction hours Gerry	Powers	Cases
1	6.88	16.3	17	13.0	28.0	3	17.5	51.75	4
2	6.80	20.2	5	7.9	24.0	20	17.2	53.0	5
3	....	....	..	11.6	26.8	26	12.1	28.2	32
4	....	....	..	10.2	22.5	28	15.0	27.0	7
5	....	....	..	....	....	..	15.5	39.9	9
6	(15.5	34.5	22)*	16.6	38.0	34	....	....	..
7	12.3	24.6	9	....	....	..	12.7	32.0	3
8	....	....	..	....	....	..	17.0	39.7	18
Mean of all	7.0	17.3	31	12.1	29.3	111	14.1	35.2	78
Mean ages	16.0			16.3			16.3		
Author's norm Gerry (mean)				10.8					
Author's norm Powers (mean)				30.2					

* 144 hours.

would have been expected from the author's norms. Two questions on nomenclature were answered by a larger percentage than is given in the author's norms. These are: (1) Write the name of the copper salt of nitric acid and (2) write the name of the sodium salt of permanganic acid. Questions on valence and those requiring computations were somewhat easier for the English children. On the other hand certain equations which were found to be comparatively easy for American children were difficult for the English. The author's norms show that 75 per cent of American children can write the simple double decomposition reaction for the action of lead nitrate and sodium chloride. Nearly 75 per cent of the English children were unable to complete the equation for this reaction. Other equations, particularly the ones for the action of sodium on water and for hydrogen peroxide on hydrogen sulfide, are easier. Incidentally this suggests the conclusion that equation writing is not a generalized but a special ability and that students are able to write only those equations which they have been taught.

Interpretations

This paper reports no adequate measure of the validity of these tests for English children. One teacher commented that the Terman Test favored American children and that the English children could hardly be expected to do well on the items of the Chemistry Tests which tested applications. Analysis of the results reveals that they did not do well on items of this type. These tests are well known and are available for commercial distribution. The interpretation of these results can be but little more than statements of the facts which the use of these measures has revealed.

The ability measures show that the mental level of these children is as high or higher than the mental level of children in the most selective of our American schools and the achievement measures reveal that the accomplishment of these children on these tests is about equal to that of children in unselected schools and considerably below the achievement of American children in the selective schools.

It should be noted especially that the students in the English schools were younger. The age level at which they begin instruction in chemistry is indeed very much lower (about four years) than the age level of American children when they enter this subject. Furthermore, the "objective tests" have not been used extensively in England and the fact that the form of the statements seemed unusual to the students may have added to the difficulty. The scores on the Test of Mental Ability, however, do not support this hypothesis.

This report is not an adequate basis for conclusion that achievement in chemistry in English secondary schools is inferior to the achievement

in American schools when the period of instruction is constant. It may only be said that there is no evidence from these results to suggest superior accomplishment and it may be said that accomplishment of English students on these tests is distinctly lower than that shown by the author's norms for American children of equivalent mental ability.

AMERICAN FIELD SERVICE FELLOWSHIPS IN FRENCH UNIVERSITIES

American Field Service Fellowships for French Universities, Inc., announces that a limited number of fellowships for advanced study in France will be awarded for the year 1928–29. Each will carry a stipend of $1200 and will be tenable for one year, with possibility of renewal for a second year if circumstances are favorable. In general, the fellowships are offered in various fields of study, including chemistry.

At present the fellowships are open only to men. A candidate:

(*a*) Must be a citizen of the United States or of one of the United States' possessions.

(*b*) Must *at the time of making the application* be a graduate of a college of recognized standing or of a professional school requiring three years of study for a degree; or if not qualified in either of these ways, must be twenty-four years of age and must have spent five years in work requiring high technical skill.

(*c*) Must be of good moral character and intellectual ability, and of suitable personal qualities.

(*d*) Must have a practical ability to use French books, both in general subjects and in his own special field.

In the absence of an absolute rule as to age, preference will in all cases be given to candidates between the ages of twenty and thirty years.

Applications must be received at the office of the Executive Secretary not later than January 1, 1928. Full information and application blanks may be obtained from Archie M. Palmer, Assistant Director, Institute of International Education, 2 West 45th Street, New York City.

Biologists to Receive Philadelphia Award. Three biologists—one a cancer expert, another one of the leading authorities on the effect of ultra-violet rays on the human system, and the third a student of snake poisons—were honored at the Academy of Natural Sciences in Philadelphia, on Tuesday, November 1. At that time the John Scott Medal, with its accompanying honorarium of $1000, was awarded to Dr. Peyton Rous, of the Rockefeller Institute in New York; Dr. Alfred F. Hess, of Columbia University, New York, and Dr. Afranio do Amaral, of the Antivenin Institute of America at Glenolden, Pa.

The Fund from which the award is made was established over a century ago in 1816 when John Scott, an Edinburgh chemist, bequeathed $4000 to the City of Philadelphia. This was to be "laid out in premiums to be distributed among ingenious men and women who make useful inventions." It is now awarded upon the advice of a committee consisting of representatives of the University of Pennsylvania, the American Philosophical Society and the National Academy of Sciences.

Dr. do Amaral has played an active part in the development of serums which can be used to prevent deaths from snake bites. Dr. Hess has in recent years been engaged in a study of the way ultra-violet light, in sunlight as well as artificial light, cures rickets, a common disease of childhood. The work of Dr. Rous has chiefly been concerned with the transplantation of cancerous cells in chickens, and has greatly increased the knowledge of cancer.—*Science Service*

A LOOK BACKWARD*

EDGAR F. SMITH, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PENNSYLVANIA

Having lectured on the history of chemistry to undergraduate and graduate students in chemistry, the writer confessed to himself on more than one occasion that American chemists had received scant attention from him. Was there a history of chemistry in America comparable to that which had been so fully outlined for other countries?

Where was this information to be obtained? Probably in the earliest American publications. Where were these printed? In the end the search was carried to Philadelphia, which for a hundred years had been the seat of the ripest culture in America. The best libraries existed there. And

Just by St. Paul's, where dry Divines rehearse,
Bell keeps his store for vending prose and verse,
And books that's neither. . . . .

Particularly was Philadelphia the center of publications of chemical literature.

As early as 1771 Benjamin Rush, a medical man with a decided preference for chemistry, issued a brochure on the subject for his students. He had been a pupil of Joseph Black, a most inspiring teacher, who made chemistry of consequence in the minds of his students. Rush was in this group. He never could cast aside his chemistry, enthusiast though he was in medicine. Hence, he emphasized it in his teaching, which began in 1769 in Philadelphia. He turned the attention of many young medical men to chemistry. Whether this was purposely done has never been determined. But he did it, and chemists of the present should be the last to reproach him for so doing. He was the first professor of chemistry in any American college or university. His brochure was one of our earliest chemical textbooks. He also wrote an exhaustive paper on the analysis of water. One smiles at much of it, but in its pioneer character it had a definite value.

It is as an enthusiastic, inspiring teacher that chemists of America are under obligations to Dr. Rush. He knew the worth of research, though in chemistry he produced nothing of value. He held an A.B. from Princeton and an M.D. from Edinburgh. He was a scholar with a fondness also for public affairs, which may be inferred from the fact that he signed the Declaration of Independence.

Many of his medical pupils gave themselves entirely to chemistry after winning the coveted medical doctorate. Among these one individual in particular deserves thanks for the splendid things he did. This was James Woodhouse (1771–1809), who had won his A.B. and M.D. from

* Paper delivered before the Section (now Division) of History of Chemistry of the A.C.S. at Richmond, Va., April 13, 1927.

the University of Pennsylvania. In his student days, so thoroughly interested had he become, that numerous papers on chemical subjects came from his pen. They had met the approval of Rush. Indeed, Woodhouse founded in 1792 the Chemical Society of Philadelphia, most members of which were young men, possessing a common inspiration and love—chemistry.

They sought also to make chemistry of service to their country. An examination of their minutes will show how genuinely active they were. They were not dilettante. They were thoroughly conversant with the chemistry of that day and their object was to use it in all possible ways. It was this society which organized a laboratory in Philadelphia. The people of the little Republic were urgently solicited to send them ores, etc., with the promise that the analyses would be made without charge and judgment given as to the value of the submitted material.

Could anything more patriotic be offered? American chemists should insist upon the world's recognition of this earliest chemical society—the first ever founded. Naturally, when the year 1792 is mentioned one is apt to turn away and in a deprecatory mood declare that our country, still in its swaddling clothes, was too young to possess a real society devoted to chemistry. In fact, the engrossing thoughts were as to *its* existence and *its* relation in the future to England and France. True, but nevertheless there was a group of men who carried forward the objects of the Chemical Society through a period of at least seventeen years. Some of its publications are still extant. They show the nature of its work, and the successors of that early group of American chemists, ought to be familiar with their contributions. Such knowledge would develop pride and respect for the fathers of the science.

In this pioneer work, Woodhouse was a potent factor. But probably his most wonderful contribution was made after Priestley came to America in 1794. In 1795, Woodhouse came into possession of his own laboratory. It is recorded that it was most modern for its day. In it worthwhile things were done. Priestley often visited it and pronounced it splendid in every particular. In it he observed Woodhouse at work—intent upon wiping out forever the phlogiston theory. On that problem Woodhouse had expended much thought and labor. In his laboratory he decomposed water and synthesized it, and also did many other fundamental things.

It is interesting to visualize that laboratory with Woodhouse earnestly experimenting with a view to controverting Priestley's views—and Priestley present all the while, as were his own American colleagues. The result was the final overthrow of phlogiston, here on American soil. Priestley admitted the remarkable skill of Woodhouse as an experimenter and conceded that his results did apparently demonstrate the nonexist-

ence of phlogiston, but he contended that he had faith to believe that if Woodhouse persisted in his inquiry, he would return to the older views. He believed in Woodhouse, who never made light of his experiments, or in any wise endeavored to humiliate him. It was Woodhouse's course to institute experiment after experiment, letting their results speak for themselves. He sought the truth, and prevailed in the end.

But a moment aside. Was, or is, it not pleasant, to think that here in America an early chemist gave such helpful aid in the overthrow of an old and enigmatic doctrine?

Most of us if questioned on this point would have said—America never bothered itself about the phlogiston theory, for there were no chemists here in the period when that theory prevailed. But now we know otherwise as the result of inquiry into the past of the science in our homeland!

American chemists founded the first chemical society in the world, and they were potent factors in the final overthrow of the doctrine of phlogiston. Do our own modern texts mention these facts? Do any texts—American or foreign—tell us about them? No, they are silent; silent because the successors of Woodhouse were ignorant of, or indifferent to, what he did. It must be remembered that at the time of that controversy, there was also a terrific turmoil taking place in politics. The old city of Philadelphia was rent and torn by conflicting views. There were threats of war with England and with France. The community in which Woodhouse quietly worked over his problems was not interested in his results, and the circle to which those results appealed was small, so that the knowledge of what Woodhouse had accomplished was not spread abroad. Foreign countries were not concerned with anything scientific from this side of the water at that particular moment. Today, however, when more than a century has passed it is proper for those who develop the history of the science before students to incorporate in their lectures this information. It is due, not only to these early investigators, but also to our country.

The laboratory of Woodhouse was the center for the scientists who congregated in those early days, not only for those who lived in Philadelphia, but those who came from other parts of the Union.

The writer has two bound volumes of manuscript lectures on chemistry by Woodhouse. Time and again he has read them. These lectures, viewed today so long after their delivery, are unique. They must have been exceedingly complete and they are suggestive of a real live mind back of them. It may be inferred that Woodhouse was a progressive in our science—that there was not anything in the literature which came to him with which he did not familiarize himself and apply such portions as he considered worth applying.

Here is another interesting historical fact which emanated from Woodhouse. Until very recently no American chemist has discovered an element. Those who in any portion of the world, have been thus fortunate have been held in high esteem by their confréres everywhere. It was in the year 1807 that Sir Humphry Davy electrolyzed molten potash and molten caustic soda, liberating for the first time their basal principles—the elements potassium and sodium. In the following year, Gay-Lussac and Thenard, by a wholly different process isolated potassium. But in the interval of time between Sir Humphry Davy's work and that of Gay-Lussac and Thenard, James Woodhouse heated wood ashes intimately mixed with lamp black in an iron crucible, and separated therefrom shining particles, which in contact with water created a turbulent reaction with the liberation of hydrogen gas. He was confident that he had the basal principle of the wood ashes. Other work and other duties seem to have intervened, so that the experiment, although repeated by him and by others with similar results, was lost. Yet, there are old papers of that period in which this isolation of potassium is set forth. The "Elements of the Philosophy of Chemistry" by James Cutbush, printed in the year 1813, made a very clear and proper statement of the discovery, but who of us—what American chemist, until recently—ever knew that such an investigation had been carried on by Woodhouse. Its importance is now recognized. It was an original idea. It could not have been prompted by what Davy did, nor was there any likelihood that the work of Gay-Lussac in any manner influenced Woodhouse, who antedated the French chemists. Again, no mention of this discovery occurs in the volumes generally consulted when desirous of reading up the history of any metal. Americans have been ignorant of this fact—too long ignorant—and it is not asking too much to request those who issue publications in the future to include that part of the story written by Woodhouse, but unknown to the majority of writers on chemistry, when telling the story of the isolation of potassium.

The manner in which Woodhouse presented this discovery in his original lectures is simple and modest in the extreme. He does not glory over his achievement but gives it as an accomplished fact without mentioning himself as in any way connected with it.

Woodhouse had never been taught directly by any European master. His inspiration had come from Benjamin Rush, and it was undoubtedly accentuated by his subsequent relations with Joseph Priestley, as well as by the discussions which were held in the Chemical Society of Philadelphia.

One can scarcely imagine the joy that those who take an interest in the early history of chemistry in this country would experience if by some turn of fortune's wheel they might come into possession of the minutes

of that early scientific body. The addresses made before it admirably exhibit what must have been the spirit of the members of the society. If we could have the actual minutes of the discussions which occurred, it would be still better.

At this time, another gifted pupil of Benjamin Rush was active in the chemical field. He had absolutely abandoned his medical career. This was Adam Seybert. Woodhouse and he were of the same age. They were probably rivals, and at times pretty active opponents. Both were unquestionably highly gifted. Seybert had done a lot of pioneer work in the analysis of air. He promptly adopted the antiphlogistic doctrine. He was one with Woodhouse in what he had accomplished in that particular direction, and was an open admirer of Woodhouse's work on the isolation of potassium.

It chanced that Woodhouse in his enthusiasm turned for a while to the mineral field, devoting himself to the analysis of minerals attracting considerable attention because of their value in a metallurgical way. Seybert was also keen in this direction and was undoubtedly a superior mineralogist. He had enjoyed study abroad, in France and in Germany, and was probably the first American who ever studied mineralogy in a German university, so that in this field at times, these two pioneers clashed. They had engaged in a rather heated discussion on the value of zinc blende, as it occurred at Phoenixville, Pa. Further, as to the value of the zinc which might be obtained from the ore, Woodhouse inclining to the view that it would probably not, in the long run, be a real source of good to the country; whereas, Seybert showed by experiment how readily the metal might be obtained and indicated uses for it. Time demonstrated that he was right. It is a pleasure to read their controversial essays. But Seybert became so involved in politics that he ceased to be a productive factor among our earliest chemists, although he ever retained an interest in the science.

So great was the influence of James Woodhouse throughout the Union—assisted, of course, by the spreading knowledge of his discoveries—that his laboratory, as we have already said, became the point to which students gathered. One of the most celebrated among these was Benjamin Silliman. Another was Robert Hare. Both worked in his laboratory; both were regular and punctual attendants upon his lectures.

It is evident in Silliman's letters to relatives and in later publications, that while he admired Woodhouse's ability as an experimenter and investigator, he entertained an antipathy for the man; largely because he believed that Woodhouse, like many others of that particular period, was an atheist.

It is true, as we now read the annals of Philadelphia society of all ranks in the last decade of the 18th century and the first decade of the 19th

century, that the impression comes that religion had little consideration. Men were too much occupied with other things, chiefly, in founding the government; and the citizenry about them was wide awake to governmental matters. The line of demarcation between the Federalists and the Republicans (who later became the Democrats) was sharply drawn. At every table discussions were upon national matters, and it happened that Woodhouse was a very strong supporter of France. He adopted the French style of dress. He was somewhat indulgent and convivial—all of which was too much for Benjamin Silliman, who had come from a rather austere New England atmosphere. Yet, when one brushes aside his caustic criticism of his master, it is quite evident that for his scientific ability he entertained the deepest respect.

As early as 1798 Woodhouse prepared a little "Laboratory Guide of Chemical Experiments." Many of us have thought that the laboratory guide which we prepared for the use of our students represented a new era in the teaching of our science, and yet any person who examines the little Guide printed 129 years ago by James Woodhouse will acknowledge that our idea was his, and that we had better content ourselves by saying that his idea became ours.

And, if one cares to follow him further, take up his edition of Chaptal's "Chemistry" in two volumes. The French book is excellent in every particular, but its value as a guide for students is immensely enhanced by the voluminous annotations of Woodhouse.

One might continue pointing to other contributions of James Woodhouse, but sufficient has been said to indicate his place and his worth; and the burden of these remarks is briefly this:

We of the present should familiarize ourselves with the earnest efforts of early chemists in our own country. The knowledge that we get should be laid before the rising generation. The time has arrived when our country, young as it is, must receive credit for what its people have done along professional, industrial, and true scientific lines.

Woodhouse's influence, throughout the decades which followed his death, to the present, may be easily traced. Some of us knew and honored Wolcott Gibbs, one of our greatest chemists. It is not a difficult matter to discover the influence of Woodhouse in certain fields of Gibbs' activity. It is true that his untiring and original mind modified and molded anew the thoughts of that day, but permeating it all there may be seen the guiding mind of the earlier American chemist.

Why should not the history of chemistry in America find its place in the chemical curriculum, which is laid before the students of chemistry now going through colleges and universities? There is no grander field for research! There is ample room for all who have the slightest inclination to turn their attention and thought that way. A great satisfaction

will come to those who undertake this work. It will bring them in contact, so to speak, with the men themselves. They will learn to know them, not only through their work, through their books, but intimately through their letters. The latter throw sidelights upon the development of our science as nothing else will.

Plane War on Insects Strikingly Justified. The warfare now being waged against forest insects in many parts of the world, by means of airplanes that swoop over the trees scattering clouds of poison dust in their wake, received a dramatic justification in Czechoslovakia recently, according to Dr. L. O. Howard of the U. S. Department of Agriculture.

During his recent European tour Dr. Howard was shown a tract of spruce woods in Czechoslovakia. This forest was divided into three parts, one of which was owned by the government, one by a wealthy nobleman, and the third by a neighboring city. When it was proposed to dust the forest from an airplane, to check the ravages of the destructive nun moth, the government and the owner of the private estate agreed to assume their share of the cost, but the municipality refused to spend the money. The aviator therefore dusted the portions of the forest for which protection had been provided, and left the municipal forest untreated.

During the past season the results of the divergent policies became apparent. The government and private parts of the forest were in thriving and healthy condition, whereas the municipal forest fell a victim to the false economy of the city fathers, and is now practically ruined by the moths. It will have to be cut down and sold for paper pulp at a fraction of its value.—*Science Service*

Plant Life Processes Imitated in Laboratory. An approximation of the process whereby living plants produce sugar from water and carbon dioxide, using the energy of light to make the combination, has been accomplished in the laboratory of Prof. E. C. C. Baly of Liverpool University. Using the most elaborate precautions against contamination of either his materials or the glass vessels used in the experiments, the British scientist and his associates have repeatedly produced substances that pass all the chemical tests for sugars.

The first tests were made with the invisible ultra-violet light as the source of energy. In these experiments, finely powdered iron and aluminum compounds were introduced into the water. These took no part in the reaction, but acted as catalysts, furnishing a large spread of surface on which the chemical action could take place.

But in nature the formation of food substances by plants is carried on by the power of visible rather than invisible light. The experimenters therefore sought a closer artificial approach to natural conditions. Since leaves have colored substances in them, colored catalysts were sought for the sugar-formation going on in the glass tubes. For this purpose carbonates of cobalt and nickel, both of which are colored salts, were found useful. With these in the tubes exposed to visible light from electric lamps, the carbon dioxide and water produced the sugars quite as readily as they came into being with colorless catalysts under ultraviolet light.

To the objection advanced by some critics, that the sugars would be formed by combination of the gas and water in the dark, Prof. Baly answers that he tried this over two hundred times, and that the results were always negative.—*Science Service*

SEARCHES IN CHEMICAL LITERATURE

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For convenience in searching, the literature of chemistry may be roughly classified thus:

I. Periodicals and serials.
   1. Original communications.
   2. Abstracts.
   3. Reviews.
   4. News and trade papers.

II. Handbooks and dictionaries.

III. Treatises and monographs.

IV. Textbooks.

V. Patents.

VI. Miscellaneous (including publications of governments, societies, companies, and individuals, consisting chiefly of pamphlets, announcements, and the like, not readily classified elsewhere).

This is a classification of what might be called the physical nature of the material, and has no essential relation to the order of procedure in making a search. It is an orderly arrangement of the kinds of literature the searcher may need to consult, not of the manner of use. Hence the discussion which follows makes no attempt to correlate the items used in a search with the order in which those items are classified.

For easy and effective use of chemical literature it is essential to know what is wanted, where and how to find it, and how to read it. Familiarity with English, French, and German is necessary. Acquaintance with other languages is helpful but not indispensable.

To know where and how to find what is wanted is to know libraries; and to know libraries the searcher must give some attention to their classifying, indexing, and shelving systems.

Two classifications, worked out in considerable detail, have been widely adopted by public and institutional libraries. One is numerical (the Dewey decimal system). The other is alphabetical (the Library of Congress system).

Nearly every large American library uses one of these; in Chicago, for example, the John Crerar Library has adopted the decimal (Dewey) system, and the University of Chicago uses the Library of Congress classification. In Europe a modified Dewey system, called the Brussels classification, is much used.

Dewey represents science by 500 and technology by 600, each with ten sub-classes which in turn are decimally subdivided. The Library of Congress represents science by Q and technology by T, again with numer-

ous sub-classes. Thus, chemistry is 540 in one and QD in the other; chemical technology is 660 in one and TS in the other.

A few minutes' study of either classification will give sufficient familiarity with the plan to aid greatly in exploring the resources of a library on any subject. The explorer should not, however, rely on classification as his sole guide.

The best procedure for collecting information from the literature varies with the amount and kind of reference work needed; but there are certain suggestions which are applicable to a great majority of chemical searches.

Given any organic compound as a search topic, the first source is Richter's "Lexikon der Kohlenstoffverbindungen" (Edition 3, 1910–12, in 4 volumes). This work covers the literature to the end of 1909, and is supplemented by Stelzner's biennial or triennial "Literatur-Register der organischen Chemie," which now covers in 5 volumes the periods 1910–11, 1912–13, 1914–15, 1916–17–18, and 1919–20–21. To use Richter and Stelzner it is necessary to know the empirical formula of the compound in question and their arrangement of compounds according to the numbers of C, H, and other atoms in the molecule.

References are given in Richter to the next source, Beilstein's "Handbuch der organischen Chemie" (Edition 3, in 4 volumes, 1893–99, and five volumes of Supplement, 1901–06). The fourth edition of Beilstein now being published by the Deutsche Chemische Gesellschaft, aims to give a complete survey of the literature of known organic compounds up to January 1, 1910. It is to be in about 16 volumes, of which 10 have been issued to date. A supplement is already being planned.

Beilstein cites references to the periodical literature within the period covered. Additional references may best be sought in the abstract indexes, which are discussed below. Fortunately, a search by empirical formula need not stop with the latest volume of Stelzner; in 1920 *Chemical Abstracts* began to publish annual formula indices. These indices use the Hill system (see *J. Am. Chem. Soc.*, **29**, 936–41 (1907)), which is superior to the Richter-Stelzner system in simplicity and in that it includes inorganic as well as organic compounds.

Given an inorganic compound, Hoffman's "Lexikon der anorganischen Verbindungen" (3 volumes, 1912–19) should be consulted. It covers the literature to April 1, 1909, and aims to be as complete for inorganic chemistry as Beilstein for organic. Hoffmann gives references to Edition 7. (1906–15) of Gmelin-Kraut's "Handbuch der anorganischen Chemie," which is the next source to be used. If Gmelin-Kraut is not available, the similar handbooks under the same title by Abegg-Auerbach and by Dammer may serve the purpose.

Those who read German only with reluctance will be relieved when the final volume of J. W. Mellor's "Comprehensive Treatise on Inorganic and

Theoretical Chemistry" is issued; they will then have a complete and satisfactory substitute for the ponderous German works. Volume 7 of Mellor appeared early in 1927. Another relief from German is the "Textbook of Chemistry," edited by J. Newton Friend. It is not quite so comprehensive as Mellor, but its publication is farther along.

Having used these reference works, the searcher is at the same stage as after consulting Beilstein for an organic compound. Given a specific search at this stage, or any topic too general for this preliminary treatment, the next procedure is to consult the abstract literature. An abstract search can be carried continuously back to 1778, if the following journals are available:

Crell's Chemisches Journal (1778–81).
Crell's Entdeckungen (1781–6).
Chemische Annalen (1784–1803).
Elwert's Magazin für Apotheker (1785–7).
Elwert's Repertorium für Chemie (1790–6).
Hermbstaedt's Archiv der Agrikulturchemie (1803–18).
Berlinisches Jahrbuch für die Pharmacie (1795–1840).
Gehlen's Repertorium der Pharmacie (1815–76).
Dingler's Polytechnisches Journal (1820 to date).
Berzelius' Jahresbericht der Chemie (1822–47).
Pharmaceutisches Centralblatt (1830 to date), (now *Chemisches Zentralblatt*).
Journal of the Chemical Society (1841 to date).
Liebig and Kopp's Jahresbericht der Chemie (1847–1915).
Wagner's Jahresbericht der Technologie (1855 to date).
Bulletin de la Societe Chimique (1858 to date).
Chemisch-Technisches Repertorium (1862 to date).
Journal of the Society of Chemical Industry (1882 to date).

These, with occasional need for specialized abstract journals, such as *Biochemisches Centralblatt* or *Science Abstracts* (Physics and Electrical Engineering), cover the field up to recent times. For any work from 1907 on, the first source to consult is *Chemical Abstracts*, with its Decennial Index (1907–16) and annual indexes from 1917.

In the use of abstract periodicals, the policy of the publishers should be borne in mind. The *Journal of the Chemical Society*,* the *Journal of the Society of Chemical Industry*,* *Chemisches Zentralblatt* and the *Bulletin de la Societe Chimique* give longer abstracts in many cases than *Chemical Abstracts*, but they make no attempt to cover the world's literature so thoroughly. There has been criticism of the omission of details in *Chemical Abstracts;* but it should be remembered that, because of financial limitations, thoroughness in one direction must be sacrificed to thoroughness in the other. If detailed abstracts of a few papers are wanted, use the

* Abstract sections now combined as *British Chemical Abstracts*.

European journals; but if a complete reference list is required on any topic *Chemical Abstracts* can be more safely depended on, for the years it covers, than any other single publication.

In addition to periodical literature, much help may be gained from the chemical dictionaries, such as Thorpe's "Dictionary of Applied Chemistry," Fehling's "Handwörterbuch der Chemie," and Ullmann's "Enzyklopadie der technischen Chemie." In certain cases the older dictionaries by Watt (Dictionary of Chemistry) and Wurtz (Dictionnaire de Chimie) may also be helpful, but much of their subject matter is now out of date. The United States Pharmacopoeia and Dispensatory, of which recent revised editions are now available, are often useful; and smaller works, such as Blücher's "Auskunftsbuch für die Chemische Industrie" or the Chemical Catalog Co.'s "Condensed Chemical Dictionary," may give information not found in the larger works.

Many reference works on special subjects may be consulted for particular topics. Thus Abderhalden ("Biochemisches Handlexikon") and Oppenheimer ("Handbuch der Biochemie des Menschen und der Tiere") have undertaken for biochemistry what Beilstein did for organic; Lassar-Cohn ("Arbeitsmethoden für organisch-chemische Laboratorien") and Weyl ("Methoden der organischen Chemie") have treated organic laboratory methods; physical properties have been collected by Landolt-Börnstein ("Physikalisch-Chemische Tabellen"), by "International Critical Tables," and by various societies and institutions; and so on through the whole list of important branches of chemistry.

It is often exasperating to find a reference for which the original is not available. Two questions then arise: Where may it be found? How may it be used?

To answer the first question, there are a number of "Union Lists" of periodicals, showing the resources of a given community. Among the most important are these:

1. "List of Medical Serials in the Libraries of Connecticut" (1919), Yale Univ. Library.
2. "Catalogue of Technical Periodicals, Libraries in New York and Vicinity" (1915), $3.00, Engineering Societies Library, 29 W. 39th St., New York City.
3. "List of Serials in Public Libraries of Chicago" (1906), John Crerar Library, Chicago.
4. "List of Serials in Public Libraries of Chicago and Evanston," $1.00, Chicago Library Club (Public Library).
5. "Coöperative List of Periodical Literature in the Libraries of Central California" (1902), (Univ. of California Press).
6. "Technical Periodicals in the Cleveland Libraries" (1916), Publicity Dept., National Carbon Co., Cleveland.

7. "Union List of Serials in the Libraries of Rochester" (1917), Public Library, Rochester, N. Y.

8. "Joint Catalogue of Periodicals in the Libraries of Toronto," (1913), $0.55, Library, Univ. of Toronto, Ontario.

9. "List of Serials in the Libraries of Philadelphia" (1908), supplement (1910), $2.00, Free Library of Philadelphia.

10. "List of Serials in Libraries in Urbana and Champaign" (1911), $1.20, Univ. of Illinois, Library, Urbana.

11. "Union List of Periodicals in the Principal Libraries of the District of Columbia" (1901), Library of Congress, Washington.

12. "Union List of Periodicals in the Libraries of Seattle" (1909), Library, Univ. of Washington, Seattle.

13. "List of Current Periodicals in the Libraries of Hartford" (1916), Trinity College, Hartford, Conn.

14. "Medical Periodicals in Buffalo Libraries" (1919), Grosvenor Library, Buffalo, N. Y.

15. "Union List of Periodicals in the Libraries of the United States and Canada," edited by Winifred Gregory; now in course of publication by H. W. Wilson Co., $60.00.

LIBRARY LISTS

Lists of periodicals received have been issued by:

1. University of California Library, Berkeley (1913).
2. Leland Stanford, Jr., University (Calif.) Library.
3. Carnegie Library of Pittsburgh.
4. University of Missouri Library, Columbia (1910).
5. University of Colorado Library, Boulder.
6. University of Arizona Library, Reno.
7. Cambridge University Library, Cambridge, England.
8. Washington University Library, St. Louis.
9. Catholic University of America Library, Washington.
10. Iowa State University Library, Iowa City.
11. Oxford University Library, Oxford, England.
12. Wisconsin Historical Library, Madison, Wisconsin.
13. New York Public Library, New York City (1920) (not published).
14. University College Library, London (1912).
15. Royal Society Library, London (1912).
16. Grosvenor Library, Buffalo (Chemistry & Medicine).
17. Boston Public Library.
18. Lloyd Library, Cincinnati.

To answer the second question, as to how library service may be utilized; many large libraries will lend by mail, either direct or through a public library, requiring the borrower to pay transportation charges. Also,

many of them own photographic copying machines and supply copies (if not hindered by copyrights) at a reasonable rate. Some do not own a machine but will arrange to have copies made by a commercial photographer.

Almost anything in chemical or technical literature can be obtained by utilizing these services. The principal sources are: in New York City, the Engineering Societies Library, the New York Public, and the Chemists' Club; in Washington, The Library of Congress, the U. S. Patent Office (particularly useful for photostats of foreign patents), and numerous libraries of Government scientific bureaus; in Chicago, the John Crerar Library and the Chicago Public; and in all parts of the country the libraries of large educational and research institutions. Many of the state libraries also have valuable reference collections.

For a comprehensive list of periodicals and of libraries in the U. S. where they may be found, see *Chemical Abstracts*, Pt. 2 of No. 20, Vol. 20 (Oct. 20, 1926). Copies may be had from the *C. A.* office at 35 cents each. This is one of the two most useful periodical lists for chemists. The other is the H. W. Wilson Co.'s monumental "Union List," of which the provisional edition is now complete and the final edition is in preparation.

Trade papers are valuable sources for price quotations and industrial facts. It must be remembered also that advertisements and manufacturers' publications often contain helpful technical information not to be found elsewhere.

Much of the literature of chemical technology is contained in patents and there only. Of the few writers on searching, only Mr. Barrows (himself a patent attorney) and E. Emmet Reid (Introduction to Organic Research) have emphasized the importance of patents in chemical searches and set forth methods of using them.

In conclusion, a few needs may be mentioned. If use of the literature is to be made easier for chemists, a prime need is that of instructing undergraduates in the use of chemical libraries. Mr. Barrows and Prof. Reid have discussed this subject, and a course of such instruction has been published by Miss Sparks, who helped the pioneering efforts of the University of Illinois along this line more than ten years ago.

Another need is for a published guide to chemical literature, on a larger scale than any now existing. It should contain lists of sources, indices and other reference aids. The five "Chemical Literature" chapters in Prof. Reid's book have helped much; and "A Guide to the Literature of Chemistry," by Crane and Patterson, just off press, is expected to meet the need adequately.

Lastly, there should be greatly increased appreciation among executives and technical men of the benefits of judicious use of the literature. Much experimental work has been and is being needlessly repeated because it is not preceded by a proper study of the prior art.

Thanks are due to E. J. Crane, Austin M. Patterson and the JOURNAL OF CHEMICAL EDUCATION for constructive criticism of the manuscript of this article.

References

1 Miss Marion E. Sparks, "Chemical Literature and Its Use," Univ. of Illinois, 1919. Price $0.60.

2. F. E. Barrows, "Investigations of the Chemical Literature," *Chem. & Met. Eng.*, **24**, 423–8, 477–9, 517–21 (March 9, 16, 23, 1921).

3. Harold Hibbert, "Art of Searching Chemical Literature," *Chem. & Met. Eng.*, **20**, 578–81 (June 1, 1919).

4. W. A. Noyes, "Chemical Publications," *J. Am. Chem. Soc.*, **42**, 2099–2116 (1920).

5. C. L. Reese, "Informational Needs in Science and Technology," *J. Ind. Eng. Chem.*, **14**, 364–8 (1922).

6. J. F. Smith, "Patent Reference Sources," *Ind. Eng. Chem.*, **16**, 527 (1924).

7. J. F. Smith, "Patent Literature as a Source of Information," *Chem. & Met. Eng.*, **34**, 160–2 (March, 1927).

8. Mason, "Introduction to the Literature of Chemistry for Senior Students and Research Chemists," Oxford: Clarendon Press, **1925**; 41 pp.

9. Bolte, "Fuehrer durch die chemische Literatur," Leipzig, **1927.** Price, Marks 3.50.

10. Kempf und Wiederholt, "Fuehrer durch die Literatur der Chemie und ihrer Nachbargebiete" has been announced but not yet published. Price, Marks 3.00; about 100 pp.

11. E. Emmet Reid, "Introduction to Organic Research," New York, 1924. The five chapters on the literature of organic chemistry constitute an important monograph on the subject.

12. E. J. Crane and A. M. Patterson, "A Guide to the Literature of Chemistry," John Wiley & Sons, Inc., New York City, **1927,** 468 pp. Price, $5.00.

Science Is Bulwark of Health Says Medical Head. Great open spaces still exist in mankind's knowledge about keeping well, Dr. Charles Value Chapin, president of the American Public Health Association, told the thousand delegates attending at the opening session of the Association's recent annual meeting at Cincinnati.

"What is not known about maintaining and perfecting the health of mankind is far greater than what is known," he declared. "The opportunities for discovery are as great today as before the days of Harvey, Pasteur and Lister."

"Today we enjoy freedom from most of the great plagues of the world, but we have little thought of the thousands whose scientific labors, accompanied perhaps by exposure to deadly germs, have conquered disease and saved countless human lives. But even now there is the greatest need for further scientific investigation.

"The science which can point to its achievements against smallpox, malaria, yellow fever, diphtheria, typhus and typhoid fevers, tuberculosis and a score of other diseases, as well as to a rapid lengthening of human life, and especially to the saving of vast numbers of infants from early death, need not be ashamed to acknowledge that some experiments have failed."—*Science Service*

QUALITATIVE ORGANIC ANALYSIS IN THE ELEMENTARY ORGANIC COURSE

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In teaching general chemistry, qualitative analysis is rather generally used only as a means of reviewing principles already studied and in training the student in careful manipulation.

A few teachers recognize in qualitative analysis a method of teaching general chemistry. Qualitative analysis can be made to aid materially in organizing and storing up the facts of general chemistry, and nothing better can be found to teach the physical principles included in the usual general chemistry text. Several authors of qualitative analysis texts have shown that it can also be used to teach the fundamental principles of quantitative analysis. Qualitative analysis is exceedingly valuable in that it interests the students.

A few teachers have considered qualitative analysis to be so valuable as a teaching tool that they have the students gradually build up their own schemes of analysis, rather than furnish them with a finished scheme.

Since inorganic qualitative analysis is not taught for its own sake, but is employed as an aid in teaching general chemistry, why should not organic qualitative analysis be used as a tool in teaching organic chemistry? Among all of the courses in inorganic chemistry, general chemistry has had the blackest name among the students. There is probably no subject which requires more teaching ability, with the possible exception of pandemic chemistry. In the organic field there is no course that has such a black name, as the first course. In our meagre experience there is no course in chemistry which is more sinned against. Methods of teaching organic chemistry have not been developed by the majority of teachers.

The purpose of the laboratory work in organic chemistry may be stated as follows:

1. To give a first-hand study of the preparation and properties of typical organic compounds.
2. To make the relation between classes, and members of classes of organic compounds more real.
3. To give the student knowledge and skill in the fundamental operations carried out in the organic laboratory.

Qualitative analysis will do all that the usual seed-catalog type of laboratory manual does in giving the student first-hand knowledge of organic compounds.

The usual course in organic chemistry takes up first the separation and purification of organic compounds, studying such operations as solution, filtration, the use of immiscible solvents, crystallization, sublimation,

fractional distillation, steam distillation, tests of purity and determination of melting and boiling points.

A course in organic qualitative analysis must necessarily cover these same items in the first few laboratory periods.

The usual course then spends some time on qualitative organic analysis studying the detection of organic substances, of C, H, N, and the halogens, but seldom relates this work to any that follows. So far our two courses are identical. By the proper selection of from ten to fifteen unknowns from the preparations generally studied in the laboratory in aliphatic chemistry such as hydrocarbons, halogen substitution products, alcohols, ethereal salts, ethers, aldehydes, ketones, acids, esters, carbohydrates, and nitrogen derivatives, we find that most of the substances generally prepared in the laboratory are actually prepared as derivatives. By using the substances generally employed as the starting point for the common preparations as unknowns, the student will very likely prepare the usual compounds, using the procedures given in the ordinary laboratory manual.

Qualitative analysis is found to have the following advantages:

1. It fulfils the purpose of laboratory work, in that it gives the student a first-hand study of the preparation and properties of typical organic compounds.

2. It not only gives the student a knowledge of the fundamental operations, but it develops a valuable technic which tends to counteract the tendency towards carelessness and sloppiness in the organic laboratory, since the preparations are made on a small scale.

3. Yields may be emphasized in this course as well as in the usual one. In fact, little emphasis is needed on this part of the work, since the unknown must be used to produce at least two derivatives in sufficient amount to be turned in as a part of the student's report.

4. It gives unusual emphasis to the fact that the library is an important part of the laboratory. We have never seen anything which stimulates as much searching of the literature as such a course does.

5. Just as in inorganic chemistry, the student is taught through qualitative analysis that the cations may be separated by the use of the properties which depend on the structure of the atom, so in organic qualitative analysis, the student is taught the fundamental conception that he is dealing with the architecture of molecules. Since group reactions precede specific tests, the student learns the rôle that each group plays in determining the properties of the molecule. When he begins to see organic chemistry from this viewpoint he is beginning to see the real thing. Many students will complete a course in organic chemistry, without having even glimpsed the marvelous relations between the compounds which go to make up what has been properly called a system of organic chemistry. When the student learns that entirely new compounds may be prepared by

using a few simple general principles, organic chemistry ceases to be to him a plaything of the immortals.

6. The student's whole attitude is changed, so that even the fine print in his text is carefully read over, to see if it will not shed some light on his immediate problem.

7. The student's interest is enlisted. The laboratory work is no longer a proposition of filling so many bottles and handing them to the instructor at the end of the course. It now becomes a series of projects, a great game which appeals to such primitive instincts as hunting and ambition. The student is never satisfied until he has completely gratified his curiosity about the contents of his unknown bottles. His curiosity is soon replaced by a feeling of power in handling problems in organic chemistry.

Some Practical Points

We use Clarke's "Handbook of Organic Analysis" as the laboratory text. Mulliken's "Identification of Organic Compounds" is almost indispensable for reference work. Every book that we can obtain on organic chemistry is eagerly examined by students who are looking for clues that will help them as they pursue their unknowns. All of the important laboratory manuals should be available, and as many other books of reference as library funds will permit.

Ten unknowns are issued in the study of aliphatic chemistry during the first half of the course, and ten unknowns are issued in the study of aromatic chemistry. The more ambitious students are allowed to analyze one or more mixtures at the close of the course, if time permits.

It is of course understood that such a course in organic qualitative analysis, should not be made too complicated. This is largely controlled by the type of unknowns selected.

Moth-Proofing Solutions Tested by Scientist. Clothes moths really do have a hard time chewing up woolen cloth and other fabrics of animal origin that have been impregnated with one of the various mothproofing solutions now in wide use, according to Dr. E. A. Back of the bureau of entomology of the U. S. Department of Agriculture. It is misleading, however, to offer an absolute guarantee of protection, he states, and the common method of merely spraying the fabrics confers but little protection. The only way to do the job thoroughly is to wet the cloth through while it is still in the whole piece, and many manufacturers have installed special machinery for this purpose. One of the favorite and most widely advertised moth-repellants consists of 97 per cent of water with 3 per cent of sodium aluminum silicon fluoride dissolved in it. Though this solution sells at a very high price under its copyrighted trade name, it really does work, if thoroughly applied. Another newly marketed class of compounds is made up of the cinchona alkaloids, chemically allied to quinine.—*Science Service*

RESULTS OF A QUESTIONNAIRE RELATING TO COURSES IN CHEMISTRY FOR STUDENTS OF HOUSEHOLD ECONOMICS

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Two years ago I was guilty of the unpardonable sin of inflicting on my fellow teachers of chemistry one of those questionnaires which have been a bane to so many of us. The percentage of answers which I received speaks well for their good nature and to me indicates that the problem over which I was puzzling was of interest to others as well as to myself. It appears to me that THIS JOURNAL is an excellent medium in which the results of this questionnaire can be presented and further discussion of the problem invited. The request was sent to those larger schools in the United States that maintain a Department of Domestic Science and was directed to both the Department of Chemistry and the Department of Household Economics.

My reasons for circulating the questionnaire were set forth in the letter which accompanied it and which is herewith given in full.

No other work in chemistry has been subjected to as much questioning and unfavorable criticism at Miami University as those chemistry courses for the students of the Domestic Science Department. At the present time the instruction in chemistry at Miami University for these students consists of one year of General Chemistry in which Smith's "Intermediate Chemistry" is used for the class-room work, two times a week throughout the year, and the companion laboratory manual for the first semester, while Baskersville and Curtman's "Qualitative Analysis" is used for the second semester, two laboratory periods of three hours each per week.

The second year, Low.y and Harrow's "Introduction to Organic Chemistry" serves to direct the work for the first semester, and Halliburton's "Essentials of Chemical Physiology" (1927, "Sherman's Chemistry of Food and Nutrition") for the second semester in the class-room two times a week. For the laboratory, special mimeographed directions are furnished. The laboratory work for the second year consists of two periods of three hours each week throughout the year.

An applied color is given to the instruction wherever possible, though a good deal of drilling on the fundamental laws and theories is carried on, particularly in the first-year work. The work of the second-year laboratory is based on applied chemistry, very largely.

A total of sixteen college credit hours in Chemistry must be earned by the successful candidate for the B.S. degree in Domestic Science at Miami.

We should like to find out, by obtaining your answers to some questions, what the consensus of opinion is relative to the amount and kind of chemistry these specialized students should be made to take.

I am submitting these questions to the Departments of Chemistry and of Domestic Science of your instituton, because you are both interested in this problem and view it from different angles, consequently frequently arrive at different conclusions.

We should particularly like to have the starred questions answered by the Domestic Science Department.

The questions asked are taken up in order and a summary of the answers given.

1. How many students from the Department of Domestic Science are there in first-year chemistry?

Ans. The answers to this are not of any great importance in this report. The number varied from fifteen to four hundred with a mean of about sixty-five for the thirty schools that reported.

2. What per cent of these fail to pass their course in beginning chemistry?

Ans. The lowest percentage given is three; the highest is thirty; the most general is fifteen.

3. How does this percentage compare with that from other departments?

Ans. No marked difference, twelve; worse, four; better, seven.

4. If there is a marked difference how do you account for it?

Ans. Two explanations for poorer work were: "Carrying more hours," "High-school training poorer." To explain their better work: "In smaller sections," "Women more conscientious than men," "Is a second-year course," were three of the reasons given. Most of those reporting professed to observe no difference in the character of the work done by them and by students from other departments. My own experience has been that the average work done is usually poorer. The causes may be the greater number of required laboratory periods which they carry and that their chemistry is a required course, not an elective, as is the case with the other students in chemistry at Miami. The latter privilege might exercise a selective effect on the students.

5. Are these students taught in separate sections?

Ans. Yes, ten. No, seventeen.

6. Should they be?

Ans. Pronouncedly opposed, thirteen. Strong supporters of segregation eight. Indifferent, nine.

Questions four and six were starred in order especially to obtain the opinion of the heads of the Departments of Domestic Science. Very few of these answered and the answers were not decisive as they were equally divided on six. One lady, particularly, pointedly resents segregation but advocates the plan practiced at the University of Illinois.

Our experience at Miami has been that the students are happier in a section of their own and this justifies the separate classes.

7. How much time is given to General Chemistry? (*a*) Laboratory? (*b*) Class-room?

Ans. Twenty report the equivalent of two laboratory periods per week throughout the school year; six report one; seventeen report three class periods; three report four class periods; and five report two class periods per week throughout the year. Evidently the amount of chemistry given the first year is about the same as that given in the regular college

course in chemistry. Of course no departure can be made where no segregation is practiced.

8. What texts are used?

Ans. The detailed tally sheet for the texts used will not be given, other than to say that, of the twenty-four reports received, the highest number received by any text was five, two texts tying with five each. Ten texts were reported, but they were all members of the regular class of textbooks in general chemistry with no special features that would appeal in a peculiar way to the domestic science student. The domestic science teachers who expressed an opinion upheld this practice of using the orthodox book in general chemistry with its emphasis and drill on fundamentals.

9. Do you depart much from the procedure of the text?
10. If so, what is the nature of the departure?

Ans. Seven institutions reported no departure; fourteen reported some departure, ranging from a change in emphasis and additional work which was optional for the student to the more important changes embodied in omissions of parts of the texts and a change in order with the inclusion of new material from outside sources.

11. Is a formal course in Qualitative Analysis given?
12. If so, how much time is devoted to it?
13. What text is used?

Ans. About one-third of those answering reported that a formal course in qualitative analysis is given. The textbook is of the simpler sort. About one half of the others (10) give some work in qualitative analysis the second semester of the first year in chemistry while the remainder (11) taught little or no analytical chemistry.

14. How much organic chemistry?
15. What text is followed?
16. Any substantial departure from the text?
17. Nature of this?

Ans. Twenty institutions reported four to five credit hours of organic chemistry and five reported a full year's work in this subject. The texts that contain the most references to the application of organic chemistry were the most popular here, if one may judge from the list given. Nine were reported, with six as the highest vote for any one. A decided departure from the text matter is reported by twelve and no departure by six. Seven are non-committal. The departure consists in omissions, such as the portion dealing with the aromatic series; limiting the discussion to the fundamentals; the inclusion of material on foods and digestion of foods; and a decided change in the character of the work in the laboratory.

18. Any Quantitative Analysis given to these students?
19. What text and how much time?

Ans. Twenty-two answers indicated that no quantitative analysis

was required though the students might elect the course and in some institutions were encouraged to do so. Seven reported quantitative as being required. The standard text was used by these and the time devoted to this subject in no case exceeded one semester.

20. How much Food Chemistry?
21. What text is used?
22. How much Physiological Chemistry?
23. What text is used?

Ans. Seven reported no course in food chemistry. Four stated that the course was elective and two as incidental. This course probably receives a good deal of attention from the teachers in the department of domestic science, particularly if the teachers have had thorough, careful training in chemistry, consequently its inclusion in the requirements in chemistry as a separate, distinct course is not so vital.

Four institutions are not giving a course of any sort in physiological chemistry while four others make the course elective. Seventeen require it and two others report the work as an incident of their other courses. Hawk is the most popular book in point of adoptions.

24. Any other courses given? What are they?
25. How much of each?
26. What texts are used?
27. In what particulars would you advise a change in the courses now given in chemistry to the domestic science students at your institution? (*a*) Length of time of courses now given? (*b*) Character of the courses now given? (*c*) New courses you would add or substitute?
28. Any other comments or suggestions you may wish to make?

Ans. The answers to this group of questions were the most disappointing feature of the questionnaire. Several schools are giving courses in textile chemistry (5) and two others propose that it might be added. One proposes adding physical and colloidal chemistry, three believe the time for the work already given should be lengthened to a full year for general chemistry and a full year for organic and physiological chemistry. One (household economics teacher) advocates less applied and more emphasis on the fundamentals; a second, no formal work in food chemistry except as it comes up in organic and physiological chemistry; a third advocates differentiation between students specializing in chemistry and those who are not by offering shorter courses for the latter but not sacrificing the quality of the course to gain students. The last suggestion would be a good one to adopt generally in our universities.

Summary

The most definite conclusions to be drawn from the answers are that General Chemistry should be taught for one year (two to three class and two laboratory periods per week) with a part of the second semester

devoted to qualitative analysis and that the work should not partake too much of applied chemistry; that a full second year should be devoted to organic and physiological chemistry with more attention paid to the application of these subjects to the special interests of the household economics students. No other generalizations can safely be made.

Globe Trotting Radio Waves Latest Trouble. Radio engineers now have to find a way to prevent their transmitted waves from going around the earth, thus illustrating the great advances that have been made in radio in recent years. Not so long ago, their problem was to get the signals across a gap of a few thousand miles. Now they have a problem because the signals sometimes not only go the shortest way between the transmitting and the receiving stations, but also go around the long way, causing an echo. They may keep on going and travel around again and again, causing a series of echoes.

This effect has been noticed in a series of experiments carried out at Geltow, near Berlin, by E. Quaeck. Records were made of signals received from Rio de Janeiro, It was found that the signals were always accompanied by this echo, and sometimes by several of them. The significant thing was that when there was a series they were a multiple of a seventh of a second after the direct signal. As radio waves, which travel with the speed of light, take just a seventh of a second to encircle the globe, it seems to indicate conclusively that the series of echoes is caused by the waves going on around and around the earth many times. As for the echo caused by the wave traveling the wrong way, it is rather strange, because the Brazilian transmitter is of the beam type which is only supposed to radiate in one direction.—*Science Service*

Cathode Rays Make Nitrogen Ice Glow Green. "Ice" of frozen nitrogen gas, which becomes solid at a temperature of 166 degrees below zero, Fahrenheit, glows with a brilliant greenish light under the influence of cathode rays. This is one of the results obtained by Prof. J. C. McClennan, of the University of Toronto, in experiments made with the cathode ray developed recently by Dr. W. D. Coolidge, of the General Electric Co.

Prof. McClennan and his associates previously made experiments with solidified nitrogen in a vacuum tube, in an effort to determine what caused a strange green light in the aurora borealis. When the auroral light is passed through the prisms of a spectroscope, a green line appears. For a long time, the origin of this line was uncertain, but a few years ago a French scientist, Prof. Vegard, claimed that it resulted from solid nitrogen when bombarded with cathode rays from the sun. Prof. McClennan, however, announced at the Toronto meeting of the British Association for the Advancement of Science in 1924, that he had found the luminescence of solid nitrogen of a different color from that of the green aurora line.

In the new experiments made with the Coolidge cathode ray tube, the experimenters find that there is not only the green luminescence while the solid nitrogen is bombarded by cathode rays, but that following the turning off of the tube, there is a greenish red phosphorescence that continues for a time. This, they believe, is due to the solid nitrogen changing from one molecular form to another, the second form being the one that continues to glow. The red glow, however, is not of the same wave-length as one that Prof. Vegard claimed to have discovered.—*Science Service*

THE PERCHLORATE METHOD FOR POTASSIUM

J. P. MEHLIG, OREGON STATE AGRICULTURAL COLLEGE, CORVALLIS, OREGON

The time-honored and widely used Lindo-Gladding chlorplatinate method for the determination of potassium has given excellent results and has long been regarded as the most reliable and convenient of all known methods for potassium. The one serious objection, however, to the continued use of this method is the very high cost of the chlorplatinic acid used as the precipitating reagent. The great scarcity and the exceptional rise in price of platinum during the World War, together with its subsequent high cost, have made it more and more desirable, almost absolutely necessary, that some method not requiring platinum be used. In industrial laboratories a considerable portion of the used platinum is systematically recovered, but such recovery involves much work, time, and expense, and it is impossible to prevent the loss of a certain fraction of the platinum in each recovery operation.

Search for a suitable cheaper method for potassium has resulted in the development of the perchlorate method which is based upon the fact that potassium perchlorate is almost insoluble in 97% ethyl alcohol, while sodium perchlorate dissolves more readily. The solubility of potassium perchlorate in alcohol of various concentrations is as follows:[1]

% alcohol by wt.	Gm. $KClO_4$ in 1 liter solvent	Gm. K equivalent to $KClO_4$
97.2	0.156	0.044
95.8	0.20	0.06
90.0	0.36	0.10

The solubility is very much decreased by an excess of perchloric acid. Sodium perchlorate is easily soluble in alcohol, but no definite data are available.

The work reported in this article was undertaken with the idea in mind of showing the practicability of the perchlorate method as a suitable substitute, especially in the hands of students, for the chlorplatinate method.

The perchlorate method[2] has been improved by substitution of a 20% solution of perchloric acid for the pure acid that was first used as the precipitating reagent. This solution keeps well and there is little or no danger of accident in handling it as there may be in handling the pure acid. As in the chlorplatinate method it is necessary to remove all ammonium salts by gently heating the mixed chlorides, being careful not to ignite too strongly as the chlorides of potassium and sodium are somewhat volatile above dull redness. The practice of evaporating with sulfuric

[1] Wenze, *Z. angew. Chem.*, **5**, 691 (1891).

[2] Scholl, *J. Am. Chem. Soc.*, **36**, 2085 (1914).

acid and heating the resulting sulfates more strongly has been found by the writer to be less reliable, especially in the case of students, due to loss by spattering, which it is very hard to prevent. This conversion to sulfates makes it necessary after weighing, if sodium is also present, to reconvert the salts to chlorides before precipitating potassium perchlorate, as the writer has found sodium sulfate not soluble enough in alcohol to permit its removal. Scholl[2] also states that sulfate ions produce an error and must be removed before precipitation of potassium. Therefore careful ignition of the chlorides is preferred to the sulfate conversion. In case the sulfate conversion is made, just enough barium chloride solution is added to the solution of the sulfates to precipitate all the sulfates, and after filtration the potassium in the filtrate (or in the solution of the chlorides in case the evaporation with sulfuric acid was omitted) is precipitated with 20% perchloric acid and taken down to fumes over a low flame. A solution made by adding 1 cc. 20% perchloric acid to 100 cc. 98% alcohol (making practically 97% alcohol) is added, the potassium perchlorate precipitate filtered off on a Gooch, washed well with more of the 97% alcohol solution, dried one hour at 120–130°, and weighed.

Advantages

The perchlorate method for potassium is a desirable one because—

1. *No Platinum Is Necessary.*—Complete analysis can be made without the use of platinum in any form. Nickel or silica crucibles may be used for fusions, vitreosil evaporating dishes may be used for evaporations, and perchloric acid may be used for the precipitant.

2. *It Is Very Economical.*[3]—Three cents worth of perchloric acid replaces $8 worth of chlorplatinic acid. The cost of recovery of platinum alone is more than the total cost of the perchloric acid. A loss of a drop or two of chlorplatinic acid is a loss of more than the cost of the perchloric acid. Accidental loss by spilling, breakage, carelessness, and recovery, combined with the large investment to be carried in platinum, are all in addition to the first factor that the recovery alone costs more than the perchloric acid. One pound of the latter will make several hundred determinations.

3. *The Accuracy Is Sufficient* for all industrial analyses. Dr. Gooch of Yale and Scholl have shown[4] that the accuracy runs from 0.1 to 0.5%.

4. *The Washing of the Precipitate Is Very Easily Done* since no ammonium chloride solution with its constant temperature requirement is used as in the chlorplatinic acid method, and the subsequent washing until free from chlorides is eliminated.

This method was adopted by the War Industries Board as a war measure

[3] Genesee Chemical Co., "Perchloric Acid," p. 9.

[4] *Chem. Abst.*, **12**, 29 (1918); *Am. J. Sci.*, **44**, 381 (1917).

for platinum conservation. The Genesee Chemical Co. of Batavia, N. Y., reports that over 10,000 ounces of platinum were replaced by perchloric acid up to the time the armistice was signed.

The following commercial concerns report that the perchlorate method has given satisfaction: Merrimac Chemical Co., N. Woburn, Mass.; American Potash Co., Antioch, Neb.; Larkin Co., Buffalo, N. Y.; Chas. A. Newhall Co., Seattle, Wash.; Swift & Co.

Among others the following schools have used the method with excellent results: Purdue, Baker University, Denver University, Illinois, Nevada, Vermont, Yale, Presbyterian College of South Carolina, Trinity College, Colorado School of Mines, and Maine. Baker reports that the best results ever turned in for potassium by the students have been obtained by the perchlorate method. University of Vermont reports that much more accurate results are obtained by beginners with the perchlorate method than with the chlorplatinate method.

In our classes at Oregon Agricultural College we have used the perchlorate method for four years with very gratifying results and see no reason why it should not be used exclusively.

Detailed Procedure

The detailed directions for the determination of potassium as followed in our laboratory when sodium is not to be determined are:

Determination of Potassium.[5]—Weigh accurately 0.5 to 1-gm. sample (beginners get better results using the larger weight), brushing into a beaker. Dissolve in 25 cc. water and add a quantity of 20% perchloric acid solution sufficient to combine with all the bases present (ordinarily 5 cc.). Evaporate, covered, over a low flame until the solution becomes viscous (about 5 to 10 cc.), cool, and dissolve the residue in a small amount of hot water. Add 3 cc. perchloric acid solution and evaporate, covered, until dense white fumes of perchloric acid are evolved. It is advantageous to evaporate with only a slight excess of perchloric acid and to repeat the process a second and sometimes a third time to insure the removal of volatile acids.[6] Cool to room temperature and add 25 cc. of the solution made by mixing 1 cc. 20% perchloric acid with 100 cc. 98% alcohol. If the potassium perchlorate precipitate is caked it should be broken with a stirring rod so that no soluble salts will escape the action of the alcohol. Filter on a prepared Gooch and wash five times with the 97% alcohol solution. Dry at least one hour at 120–130° C. and weigh. Calculate % potassium.

The results on pure potassium salts as obtained by our students and by the writer are given in the following table.

[5] Adapted from Mahin, "Quantitative Analysis," McGraw-Hill Book Co., 3rd Edition, **1924,** p. 91.

[6] Scholl, *J. Am. Chem. Soc.*, **36,** 2087 (1914).

POTASSIUM IN SALTS

KI
Calculated %K—23.55

Howard	23.27
Macdonald	23.61
Stokesbary	23.21
Drane	23.14
Kinsey	23.91
Roll	23.50
Voytilla	23.17
Thielke	23.56
Student ave.	23.42
Mehlig	23.54, 23.53

KNO_3
Calculated %K—38.68

Clinton	38.93
Huntington	38.69
Ford	38.63
Clarke	38.49
Anderson, O. M.	38.54
Lerch	38.70
Student ave.	38.66
Mehlig	38.66, 38.63

KCl
Calculated %K—52.43

Sinniger	52.28
Alvord	52.23
Tindula	52.07
Adams, B. R.	52.21
Shores	52.28
Student ave.	52.21
Mehlig	52.24, 52.35

$KClO_3$
Calculated %K—31.91

Bauer	31.93
Moshberger	31.74
Student ave.	31.84
Mehlig	31.93, 31.91

K_2SO_4
Calculated %K—44.88

Holm	44.71
Sisson	44.78
Espino	44.98
Lee	44.97
Afroilan	44.77
Leland	45.04
Student ave.	44.84
Mehlig	44.88, 44.84

KH_2PO_4
Calculated %K—28.72

Fahey	28.25
Fleshman	28.89
Locke	28.70
Thayer	28.41
Mayer	28.81
Stearns	28.83
Harris, M.	28.82
Polson	28.85
Pebley	28.84
Schneider	28.91
Student ave.	28.73
Mehlig	28.57, 28.54

$K_2Cr_2O_7$
Calculated %K—26.59

No student analyses made	
Mehlig	26.64, 26.59

KBr
Calculated %K—32.86

Dhawan	32.80
Petersen	32.48
Swanson	32.48
Student ave.	32.59

$KC_2H_3O_2$
Calculated %K—39.85

Rohrman	39.84

Determination of Potassium in Soils

For three years only pure salts of potassium were used as samples, but this year the work was extended to include ten samples of soils obtained from the chemistry laboratory of the Oregon State Experiment Station. These had been analyzed for potassium by the official chlorplatinate method by C. F. Whitaker, Assistant Chemist in the station. Our results will be given in comparison with his. As soils contain complex silicates of potassium, the samples were prepared for analysis by a modified J. Lawrence Smith fusion. The official method calls for fusion in a special tall platinum crucible, followed by treatment of the residue with water to dissolve out potassium chloride. After filtration most of the calcium, iron, and aluminum is precipitated by ammonium oxalate and ammonium carbonate. The filtrate is then evaporated in a platinum dish and the residue heated to expel all ammonium salts. This residue upon solution in water is ready for the determination of potassium by either the chlorplatinate or perchlorate method.

Jones and Reader[7] have shown that an electric muffle furnace and silica crucibles of the ordinary shape can be used for the fusions with highly satisfactory results, if certain temperature limits are observed. For perfect fusions the muffle must reach a temperature of 812°C., and to avoid loss of potash by volatilization of potassium chloride, the temperature must not exceed 855°C. Fusion at the lower temperature for approximately ninety minutes and prompt removal of the crucibles from the muffle when the temperature reaches 855°C. give practically the same results. The first is probably the safer procedure, but the second is the quicker. A thermo-couple connected to a millivoltmeter makes a satisfactory temperature indicator. Jones and Reader[8] give figures to show that there is an appreciable loss of potassium chloride by allowing the temperature of the muffle to exceed 855°C. or by heating at the lower temperature of 812°C. for more than two hours. The number of fusions that can be made at the same time is limited only by the size of the furnace. Lessened expense results from the use of electricity instead of gas, replacement of expensive platinum by relatively cheap silica crucibles, and in the larger number of samples one analyst can handle at one time. The sacrifice in accuracy was found by the above workers to be inappreciable for practical purposes. As many as twenty-four fusions were made in one crucible and it was still serviceable.

After the fusion the melt is slaked and digested with hot water, filtered, evaporated to dryness, the residue taken up in water, filtered, evaporated to dryness a second time, taken up in water, and again filtered. This double evaporation and filtration removes calcium, iron,

[7] *Soil Sci.*, **12**, 419 (1921).

[8] *Ibid.*, pp. 422, 424.

and aluminum salts. The final filtrate is then ready for analysis by either method.

Detailed Procedure for Soils

The details of the procedure as followed by the experiment station chemists[9] and by us are given herewith:

Modified J. Lawrence Smith Fusion for Potassium in Soils.—Cover the bottom of a silica crucible with the fusion mixture (1 part by weight of ammonium chloride to 8 parts precipitated calcium carbonate very intimately mixed). Accurately weigh 0.5 gm. sample and without removing sample from the balance pan weigh approximately 4.5 gm. fusion mixture on top of it. Transfer sample and mixture to an agate mortar and mix very intimately by thorough grinding. Transfer to the silica crucible. Place the crucible in an electric muffle furnace at room temperature. Turn on the current and control the temperature by means of a thermo-couple connected with a millivoltmeter. Remove the crucible promptly when the reading 32 on the millivoltmeter is reached (855°C.). The time usually required is about 1 hour, 20 minutes.

When the crucible has cooled loosen the fused mass with a stirring rod and transfer to a casserole. Grind thoroughly with a pestle the solid in the casserole after adding about 50 cc. hot water. It is best to let this slaking and digestion take place over night. Decant onto a filter and grind the residue a second time in the casserole with the pestle before final transference to the filter. Filter into a 600-cc. beaker, washing the residue on the paper with hot water until the volume of the filtrate is about 300 cc. Evaporate the filtrate to dryness on the steam-bath. Take up the residue with 25 cc. hot water, breaking it up with a stirring rod, and filter into a 250-cc. beaker, washing the residue on the paper with hot water until the volume of the filtrate is about 150 cc. Evaporate the filtrate to dryness on the steam-bath. Take up the residue with 15–20 cc. hot water and filter into a 250-cc. beaker. Wash the residue on the paper at least three times with hot water. From this point the chlorplatinate method was followed by the station chemist and the perchlorate method by our students and the writer. Because of the small amount of potassium in the soils only 3 cc. perchloric acid solution need be used for the first addition and 1 cc. for the second addition, or enough to insure dense fumes on evaporation.

The results of the analyses are given in the following table. Results obtained by analyst C. F. Whitaker of the Experiment Station using the official A. O. A. C. chlorplatinate method are given at the right of the soil numbers.

[9] Jones-Reader modification of A. O. A. C. method, not in print.

POTASSIUM IN SOILS

No. 15090—2.595% K	% K	No. 15190—0.924% K	% K
Burton	2.554	Davies	0.886
Weber	2.660	Kidd	0.914
Student ave.	2.557	Student ave.	0.900
Mehlig	2.620	Mehlig	0.928
No. 15130—1.056% K	**% K**	**No. 15191—0.852% K**	**% K**
Gleeson	1.043	Covert	0.794
Hume	1.083	Friedman	0.786
Student ave.	1.063	Student ave.	0.790
Mehlig	1.048	Mehlig	0.816
No. 15172—1.146% K	**% K**	**No. 15194—0.489% K**	**% K**
Ervin	1.162	Hoffman	0.593
Johnson	1.157	Long	0.553
Student ave.	1.160	Student ave.	0.573
Mehlig	1.122	Mehlig	0.486
No. 15180—1.082% K	**% K**	**No. 15198—0.871% K**	**% K**
Bryant	1.139	Gadwa	0.914
Bump	1.137	Hall	0.816
Student	1.138	Student ave.	0.865
Mehlig	1.081	Mehlig	0.858
No. 15182—0.589% K	**% K**	**No. 15207—0.462% K**	**% K**
Adams, C.	0.584	Beyers	0.552
Page	0.604	Mehlig	0.449
Student ave.	0.594		
Mehlig	0.525		

These results together with those obtained on potassium salts would indicate that the perchlorate method is just as reliable as the chlorplatinate method and can be substituted for it.

Our special thanks are due Professor J. S. Jones and Mr. Whitaker of the Experiment Station laboratory for their hearty coöperation in the work on the soils.

Summary

1. The perchlorate method for potassium is very economical.
2. It is very easily carried out.
3. It eliminates time spent in platinum recovery.
4. Its accuracy is sufficient for all industrial analyses.
5. It gives good results in the hands of beginners.
6. Its use by industrial laboratories is increasing.
7. It has given results on soils that compare very favorably with those obtained by the official A. O. A. C. chlorplatinate method.
8. Its use is strongly recommended.

A LECTURE-TABLE DEMONSTRATION OF ELECTROLYTIC WHITE LEAD

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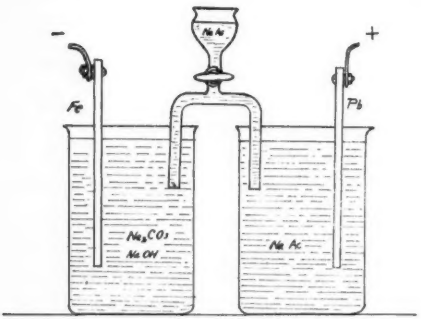
It is obviously impossible to demonstrate the preparation of white lead by either the Dutch or Carter processes on the lecture table. The method given in this article provides a rapid and effective means of illustrating one of the industrial processes used in the manufacture of this important lead compound. It also shows the necessity of using a two-solution cell where a single solution would not be feasible.

Apparatus.—A small lead anode should be made from sheet lead about three inches long, one inch wide, and having a small binding post in one end. A similar cathode is made of iron, and also has a binding post at one end. Two one hundred-cc. beakers, and a small U-tube with stopcock and reservoir are also needed. Two solutions are prepared, one of seven per cent Na_2CO_3 containing a little NaOH, and the other five per cent $NaC_2H_3O_2$. Any source of direct current of about one hundred volts may be used, preferably with a lamp bank for control.



APPARATUS FOR LABORATORY PREPARATION OF ELECTROLYTIC WHITE LEAD

Method.—The two beakers are placed side by side. One is filled with the five per cent sodium acetate, and the lead anode inserted. The other is filled with the sodium carbonate, sodium hydroxide solution, and the iron cathode placed in position. The U-tube is next inserted, and the liquid junction made by allowing the sodium acetate, in the reservoir, to displace the air in the tube. Instead of using the U-tube as shown in the figure, it is possible to use a simple U if care is taken in filling and inserting so that no air bubbles are present to spoil the liquid junction. The lead anode is connected to the positive terminal of the source of current, and the iron cathode to the negative. The cell is now ready for operation.

When the current is turned on the solution about the lead anode becomes milky, and within a few minutes white lead begins to settle to the bottom of the beaker. The lead anode should be raised up and down from time to time to dislodge any adhering white lead which tends to diminish the efficiency of the operation. Bubbles of hydrogen may be seen rising from

the iron cathode. These bubbles should not be allowed to enter the end of the tube in this portion of the solution.

Explanation.—The simplest explanation of the phenomena observed may be given in terms of ions. The lead dissolves from the anode in the sodium acetate solution, as lead acetate or lead ions.

$$Pb + 2C_2H_3O_2^- = Pb(C_2H_3O_2)_2 + 2\epsilon$$

The reaction at the cathode may be given as follows:

$$2H_2O + 2\epsilon = H_2 + 2OH^-$$

The OH^- and CO_3^{--} ions pass up over the liquid junction into the anolyte where they react with the lead ions, precipitating white lead.

$$3Pb^{++} + 2CO_3^{--} + 2OH^- = Pb(OH)_2 \cdot 2PbCO_3$$

This equation may also be written:

$$3Pb(C_2H_3O_2)_2 + 2Na_2CO_3 + 2NaOH = Pb(OH)_2 \cdot 2PbCO_3 + 6NaC_2H_3O_2$$

The electrons are of course carried across by the external circuit giving the cathode reaction represented above. It will be seen that the process will continue as long as the concentration of the sodium carbonate is sufficient. The sodium acetate being constantly regenerated. A little NaOH was included in the catholyte at the start to hasten matters. Its presence is not strictly necessary as OH^- is released at the cathode as soon as current is supplied. The white lead formed may be filtered out of the anolyte and will be found to be of very fine quality.

Arsenic "Smudge-Pots" Fight Europe's Insects. A new style of chemical warfare against insect pests of forest and orchard trees which may partly or wholly replace the time-honored but expensive methods of spraying and dusting, is described by Dr. L. O. Howard, chief of the Bureau of Entomology of the U. S. Department of Agriculture. He saw it being tried out during his stay in Europe this summer.

The method was developed by chemical warfare technicians, who wished to turn their military talents to use in the arts of peace. The materials used resemble somewhat the "smoke candles" used to generate a smoke screen in wartime, except that the fumes given off by these peacetime chemical smudges contain arsenic, the favorite poison for use against chewing insects.

In some places the arsenic smokes are set on the ground at intervals, and in others they are carried through the grove or orchard on long poles by a rank of men. In either case they fill the air with a white fog, which takes about an hour to settle. At the end of that time an examination of the leaves shows that they are covered with a thin deposit of arsenical residue. Results are not all in from the first experiments, but if the new method is effective against the insects its cheapness and quickness of operation will be strong arguments in favor of its general adoption.—*Science Service*

A NEW AUTOMATIC HYDROGEN SULFIDE GENERATOR

H. H. BARBER, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA

The preparation of large amounts of hydrogen sulfide by the action of an acid on ferrous sulfide has presented to a number of schools a problem which has not been satisfactorily solved. The Kipp generator is satisfactory when the number of students is small, but as soon as the number becomes large, requiring several Kipp's or individual generators, dissatisfaction with this method of obtaining hydrogen sulfide has been felt. The glass Kipp is easily broken. It is not easily filled or cleaned, and as it has only one outlet, unless attached to a pipe with several outlets, the use is very limited. To overcome these difficulties, various types of generators have been proposed, and have more or less satisfactorily replaced the Kipp for the preparation of hydrogen sulfide on a large scale. Most of these generators, however, have serious defects. Some are hard to fill and hard to clean. Others feed the acid onto the ferrous sulfide at the top of the column. This type of generator soon ceases to generate hydrogen sulfide as the fine ferrous sulfide and insoluble material are carried toward the bottom of the column and form a mass which stops further flow of the acid over the ferrous sulfide. This mass then forms a hard cake that must be removed, usually with difficulty, before the generator can be used again. The generators with attached storage tanks require considerable space, are expensive, and are not easily handled. Defects in construction, trouble in handling, and back pressure of the gas often cause the hydrogen sulfide to escape into the generator-room with attendant dangerous, disagreeable, and ill effects.

Recognizing the need of a better hydrogen sulfide generator for large classes, experiments were carried out on various types of generators. Numerous arrangements were tried, and experiments were conducted with several new designs.

The generator described in this article is the one that gave the best experimental results. A battery of three has been in use for some time and has been found to be entirely satisfactory.

The generator is constructed of acid-resisting earthenware and consists essentially of five parts, which, for convenience of description, are designated *A*, *B*, *C*, *D*, *E* (Fig. 1). The flanges of parts *A*, *B*, and *D* have flat ground surfaces.

The assembled generator is shown in Fig. 2. The generator is set on a flat place which is built on a slightly slanting cement floor with a raised gutter arrangement at the lower edge of the slant. The gutter leads to a sewer-connected outlet. Behind the generator at a height of 18 inches, a shelf is placed on which the acid container rests. The whole arrangement is enclosed in a room provided with an outlet ventilating

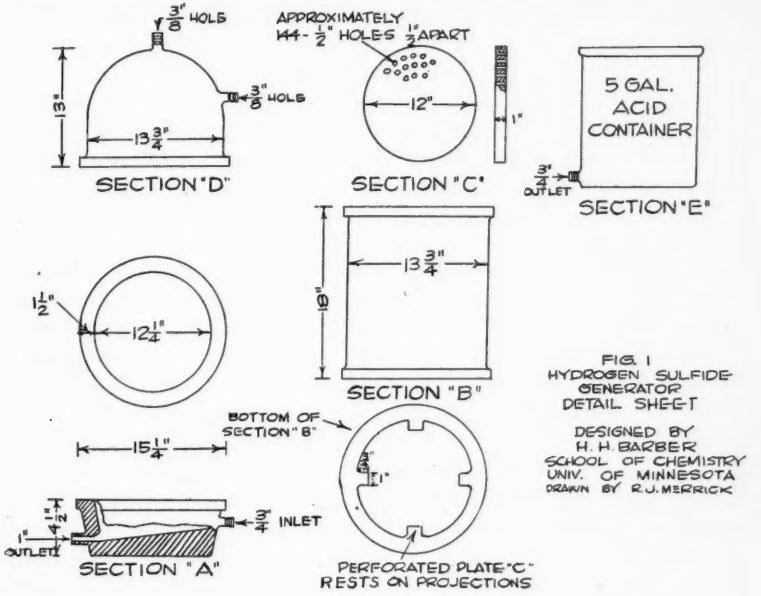


FIG. 1
HYDROGEN SULFIDE GENERATOR
DETAIL SHEET

DESIGNED BY
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UNIV. OF MINNESOTA
DRAWN BY R.J. MERRICK

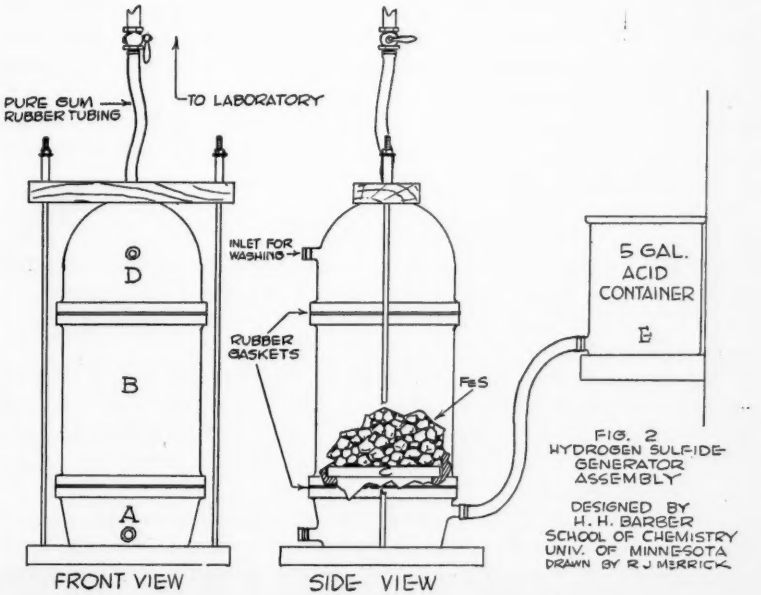

FIG. 2
HYDROGEN SULFIDE GENERATOR
ASSEMBLY

DESIGNED BY
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SCHOOL OF CHEMISTRY
UNIV. OF MINNESOTA
DRAWN BY R.J. MERRICK

fan. To this room iron pipes are run for leading the hydrogen sulfide to the various laboratories. This room is also provided with an outlet for cold water.

In order to render the generator gas-tight, the parts are held in place by two iron rods $1/2$ inch in diameter. These rods are set in the cement floor. They are 18 inches apart and have a length of 39 inches from the surface of the floor. The rods are threaded for 3 inches at the top. An oak clamp, 22″ x 7″ x 2″, with a 2-inch hole at the center and a $5/8$-inch hole in the middle of the clamp, 2 inches from each end, is provided. The manner of using the rods and clamp is shown in Fig. 2.

The generator is set up by placing section *A* between the iron rods. The upper opening is connected to the acid container by pure gum rubber tubing. The lower opening is closed with a rubber stopper. On the ground flange a soft rubber gasket, $1/8$ inch thick, is placed. Section *B* together with section *C* in place is now set on section *A*. Section *B* is filled with lump ferrous sulfide. (Ferrous sulfide pieces about 2 inches in diameter are suitable. Larger or smaller lumps may be satisfactorily used. No screening for size is necessary, but a large amount of very fine material should be avoided, especially at the bottom of section *B*.) Another rubber gasket is placed in position on the upper flange of section *B*, and then section *D* is set on. The upper outlet of *D* is attached to a piece of $3/4$-inch inside diameter pure gum rubber tubing. The tubing is passed through the 2-inch hole in the oak clamp, and then connected to the gas supply lead. The distance from the top of the generator to the gas supply connection should be about 18 inches. This gives flexibility in lifting off and on section *D*. The iron rods are now inserted through the holes at the ends of the clamp and sections *A*, *B*, and *C* firmly brought together by screwing down the nuts. The other outlet in section *D* is closed with a rubber stopper.

Operation of Generator

Close the valve in the pipe above the generator. Add to the acid container $4\,1/2$ gallons of water, and then allow 2 quarts of concentrated commercial sulfuric acid to run slowly into the water. Open the valve above the generator.

When the stopcocks in the laboratories are opened the flow of the acid will so regulate itself, owing to the construction of the generator and the large surface of ferrous sulfide present, that hydrogen sulfide will not bubble back through the acid container unless a heavy flow of gas is suddenly stopped.

After the acid has become spent, the rubber stopper at the bottom of section *A* is removed. The rubber stopper in section *D* is now removed and through the opening a stream of water is passed until it runs prac-

tically clear. By this treatment all of the insoluble material carried into section *A*, the ferrous sulfate, and silt will be removed and a fresh clean surface of ferrous sulfide will be left in the generator. The acid container should also be washed. Allow the water to drain from the generator; close the openings in sections *A* and *D;* fill the acid jar with fresh acid. The generator is now in fine operating condition.

If a thorough washing of the ferrous sulfide is carried out after each lot of acid is spent, it will not be necessary to open the generator until the whole of the charge, about 200 lb., of ferrous sulfide has been used up, as the ferrous sulfide will move toward the bottom of section *B* as it is dissolved, and the acid lead from section *E* to section *A* will not become clogged by the insoluble material.

One generator of the size described in this article will supply hydrogen sulfide in sufficient quantity for 200 students working in qualitative chemistry when closed precipitation flasks are used.

These generators may be obtained from the ceramic companies for about $37.00. The cost of hydrogen sulfide when prepared from commercial ferrous sulfide and sulfuric acid will be approximately 25¢ the pound.

Summary

A new automatic hydrogen sulfide generator, simple in construction, inexpensive, and positive in operation has been described.

The generator is easily filled and cleaned, and does not clog in operation.

The generator is not easily broken, and may be constructed in any size to suit the laboratory requirements.

The generator may be easily secured on specifications from the ceramic companies.

Airship Gas Source Seen in Atmosphere. Airship makers take courage. Helium, the valuable safety gas so much in demand for filling balloons, may be obtainable in unlimited quantities from ordinary air. This optimistic suggestion comes from Dr. Frederick G. Cottrell of the Fixed Nitrogen Laboratory, one of the country's foremost experts in the chemistry of the atmosphere.

Unfortunately, there is but one part of helium in 180,000 of common air. On the other hand there is a lot of air. Dr. Cottrell's hopes are based on the prospect of separation of air into its component gases in a large industrial way, whereby the oxygen, in particular, is to be more efficiently used in combustion. When this sort of wholesale air analysis is undertaken, the helium content of the atmosphere will unquestionably get attention.

It is estimated that some fifty million cubic feet of helium per year go through the blast furnaces of America, along with the enormous volume of air feeding the fires. If it could be salvaged, this quantity of helium alone would revolutionize the airship industry.—*Science Service*

Chemical Digest

CULTURE OR VOCATION?

It is a common view among our educators of today that while culture and vocation are not antagonistic they have nothing in common. It is a common belief that the standards of culture lie in that part of life and education which is unrelated to the economic. Dr. Theodore H. Eaton in a recent article[1] writes:

> Another view common among educators and the laity goes a step further and assumes that "the good life" and good education consist in a proper "balance" between vocational experience and cultural experience. The "subjects" of school and college are divided into vocational studies and cultural studies. Certain studies are vocational and narrowly utilitarian, others are cultural and broadly—well, not exactly useless, but, well, cultural and breadth-giving. At any rate each serves as a balance to the other in the development of a "well-rounded" education. For every minim of the vocational virus there must be injected one, or sometimes two or three minims of the cultural anti-toxin. Thus in the high school a unit of carpentry, animal husbandry, or cookery is compensated by a unit of algebra, or ancient history, or both. Many "vocational curricula" both in secondary schools and colleges are built upon this principle of balance or compensation.

It is held that the purpose in teaching the subject and not the subject itself determines the kind of educational value to be derived from it. That given in the arts college is cultural and that in the law school vocational. Dr. Eaton writes further:

> The extreme view that the cultural and the vocational in education, if not in life also, are in deadly antagonism, and that compensation or balance between the two is an intolerable compromise between good and evil is familiar in the writings of certain Neo-Ciceronians who have rallied to what they call a "*defense* of the classics." These good men and women are narrowly explicit in the definition of culture. It is possession of the languages and the traditions of the Golden Age and the Renaissance. As to vocation they are shudderingly vague. It is something modern and materialistic whereby men acquire filthy lucre.

It is widely accepted among thoughtful men that culture is a process of evaluating life and living it according to the values set upon it. The determination of the scope of life and the standards by which judgment and conduct shall be governed, however, presents difficulties. We again quote Dr. Eaton:

> The dualists appear to agree in this: That out of the life which falls within the purview of culture we must throw vocation. There is nothing of culture in the critical evaluation of one's own primary activities and service, but there may be culture in

[1] "Dualism in Education," *The Wiley Bull.*, October, 1927.

the critical appreciation of the vocation of another. There is cultural value in the study of poetical, musical, or architectural technic if one is or is to be a farmer, but none in the technic of technology or agriculture. To be sure, when they are pressed, the proponents of the dualistic views usually hedge a little. The poet, the musician, and the architect may extend life into vocation and find some culture; the farmer, the carpenter, and the cook may not—except that the latter may do so possibly in France where cookery is under the tutelage of the Immortals. There is culture for the engineer in the study of Caesar's bridge—particularly if he read the account in the original—but none in the study of the Hudson tunnel. There is culture for the farmer in the study of Jacob's defrauding of Esau, but none in the study of Bakewell or Davenport. If a man's vocation be modern or humble no cultural value exists in the study of it; if it be ancient and honored there may be cultural values in the study of it.

Greek culture was based upon the best that was, not upon the best that had been long ago. Dr. Eaton writes:

To some of us it seems that just as the Greeks found it possible to develop standards not of a remote and blindly worshipped past, so it may be possible for us to look to other than classic days, even to the always degenerate present, for certain standards of truth and beauty. No time or group has produced the best in everything. Our materialistic day has developed standards in many fields of activity that no classic period has ever approached. In science, in philanthropy, in medicine, as in the vulgar arts of agriculture, commerce, and industry, we pass on a heritage much enriched by our own contributions. Some of the "best that has been said and known" and *done* is being said and known and done in this our day and generation. The heritage of social environment through reaction to which the individual grows in the process of culture is neither exclusively of a classic past nor exclusively of the life not economic.

The meaning of culture, some would say, is conformity to convention. However, according to Dr. Eaton:

Conformity to convention will hardly suffice to distinguish the cultural from the vocational. Vocations are full of conformities to convention. Many professional men are slaves to the conventions of their professions. One who has spent a few weeks in a hospital or has dealt extensively with lawyers may readily confirm the statement. The vocations of household and hotel servants are bristling with conventions; the unionized trades abound in them. Merchants and "business men" are hedged in by them. Yet most of the conventions of vocations, as those of leisure, are rational and meaningful. They are manifestations of considered values. From the standpoint of culture in the broader sense, however, it would seem that understanding and critical acceptance or rejection of them are far more significant than the habit of conformity. The cultured man may manifest his culture as truly by non-conformities as by conformities. The basis of dualism does not lie in acceptance of group conventions.

It is suggested by one essayist that culture is selfless and that vocation is selfish. The following paragraph concludes Dr. Eaton's article:

It is selfless, then, to seek education as a ticket of admission to distinction, or to seek it as a means to pleasing one's self. Stigmatizing vocational education as "preeminently selfish" or quite the opposite in motive to the selfless education illustrated, our essayist pays to those who seek education from vocational motives a compliment as unintentional as it is undeserved. But her view is by no means uncommon or without influence on education. "Art for art's sake" and "science for the sake of truth" are

almost universally held in higher esteem than art for service and science for the welfare of mankind. To paint for the joy of painting, or to study for the satisfaction of one's intellectual curiosity is, by some strange perversity, more worthy than to paint because others need beautiful pictures, or to seek our new principles because the economic world has need of such. To move directly to the satisfaction of self is less "selfish" than to move indirectly to such satisfaction by serving others. Only by such a standard of selflessness is vocation to be set apart from culture.

W. R. W.

RUBBER FROM COAL

Everybody in America who owns an automobile—or rides in one—is concerned by the two recent announcements of the German Chemical Trust. First, that synthetic gasoline may be made at marketable prices from coal. Second, that synthetic rubber may be made at marketable prices, also presumably from coal. Since we consume more gasoline and rubber than any other people in the world we are most interested in the reported discoveries. They belong to the news to be classified as "important if true."

One reason why American experts are inclined to question this present statement of the German Chemical Trust that synthetic rubber would "soon appear on the world markets as a commercial commodity, equal to natural rubber and cheaper in cost" is because they remember that same claim was made by the same parties fifteen years ago and it did not turn out to be true. At the International Congress of Applied Chemistry in New York in 1912, Dr. Carl Duisberg exhibited with justifiable pride two automobile tires made of artificial rubber and rashly boasted that "synthetic rubber will certainly appear on the market in a very short time." But "in a very short time" after that Germany was barricaded by the Allied Armies and rubber was wanted at any cost, yet the German army automobiles had to run on bare tires.

But since the war very great progress has been made in Germany in the manufacture of organic compounds from coal. The Bergius process for making petroleum by combining hydrogen with coal has shown sufficient promise of proving practical and profitable that the Standard Oil Company of New Jersey has invested in it. The Fischer process of making methanol from coal has cut under our process of making it from wood.

Now the products of these processes for the liquefaction of coal include various compounds out of which rubber may be made, for instance, acetic acid, acetone butadiene, and isoprene. So it is quite likely that some catalyst has been found which will short-circuit the process of preparation of one of the various materials and so cheapen the passage from coal to caoutchouc.

But after the chemist has done his work and produced a substance identical in composition to the natural rubber the task is still only half done, for the milk that exudes from the cuts in the rubber tree is made up of miniature globules which confine in an elastic membrane a network of minute rods and chains enmeshed in lighter liquid. When the drops are stretched the nets form a stiff lattice held in place by strong tension of the covering skin. In this crystalline structure of the natural rubber, revealed only recently by the x-ray, lies the secret of its usefulness, its incomparable elasticity and resiliency. Rubber is easy to stretch but hard to break. Hitherto, none of the artificial rubbers have the peculiar cellular structure of the natural and, therefore, none has equaled its "stretchability." The rubber made by the Germans during the war was found satisfactory for hard rubber articles but not for soft. If now this difficulty has been overcome as well as the high price of production, the future of synthetic rubber is assured.—E. E. SLOSSON, *Science Service*

ABSTRACTS

The World's Inorganic Nitrogen Industry. F. A. ERNST AND M. S. SHERMAN. *Ind. Eng. Chem.*, **19**, 196–204 (1927).—According to figures given, commercial nitrogen compounds produced by fixation from the atmosphere compete on the market very successfully with Chilean nitrates and ammonia from coke ovens, in peace time. In war time, such compounds may be a nation's only supply. Inorganic nitrogen used by the world in 1925, was furnished by Chilean nitrates to the extent of 31 per cent, by the coke and gas industry, 24 per cent, and by atmospheric fixation processes, 45 per cent. The authors believe that the production of ammonia by direct synthesis from nitrogen and hydrogen will lead the three fixation processes (hydrogen-nitrogen, electric arc, and cyanamide) in development. Sources of nitrogen for the entire world are discussed, production statistics and cost data being given. The leading nations of America and Europe are considered separately. V. R. THAYER

Solid Carbon Dioxide—A New Commercial Refrigerant. D. H. KILLEFFER. *Ind. Eng. Chem.*, **19**, 192–5 (1927).—Solid carbon dioxide "snow," produced commercially in large quantities at reasonable cost, may easily revolutionize the methods of refrigeration in transportation. The material has been marketed as "dry ice" for the past two years. K. sketches the method of production, involving combustion of coke in a heat-resistant boiler installation, with a slight excess of air, purification of the flue gases, absorption of the carbon dioxide in sodium carbonate solution, liberation of the pure gas by subsequent heating, and solidification through expansion of the highly compressed material to atmospheric conditions. The conservation of heat by means of exchangers makes economical manufacture possible. Some advantages listed are: insulating effect of the gas evolved, greater cooling capacity per unit weight refrigerant, ability to produce lower temperatures than are possible with water ice, absence of liquid material, preservative action of gas evolved. V. R. THAYER

The Teacher: Being, Knowing, Doing. LIVINGSTON C. LORD. *Am. Educ. Digest*, **46**, 531 (August, 1927).—The teacher is judged by what he is, what he knows, and what he does—by his character, his knowledge, his skill.

There can be the best teaching only in the best atmosphere. The atmosphere cannot be good unless the teacher has the easy mind which comes from the mastery of his subject. The teacher must be hospitable toward the ideas and answers of all sincere and earnest students, no matter how absurd these answers may be.

Teaching is a complex process. Many complex wholes, perhaps all, may suffer from the lack of some element, from the excess of some element, from the presence of some element. The class-room recitation is no exception—it may suffer from lack of drill, too much drill, or from sarcastic remarks. Indulging in autobiography or cheap joking may injure a recitation as much as sarcasm.

The unskilled teacher uses material which is so interesting in itself that the material has the attention and not the relations it is to illustrate. Or he may multiply illustrations, instances, examples, and analogies hoping every pupil will get some. The skilled teacher uses but one which every pupil will get, if he is able to get the idea at all.

The skilled teacher knows when to be the mediator and when the pupil should come into immediate touch with the thing to be learned; when to tell and when to teach; when to develop and when there should be no development. He sees that through the recitation knowledge is converted into faculty, facility, habit, opinion, culture. J. W. H.

College Standards Discussed. ANON. *Am. Educ. Digest*, **47**, 27 (Sept., 1927).—A report of the "Institute for Administrative Officers of Institutions of Higher Education," recently held at the University of Chicago.

As a result of the discussions following speeches, the Institute recommended the following steps to every college as conducive to greater educational efficiency:

At least one survey course in sciences or the social sciences and the introduction of general reading courses.

A comprehensive final examination in the field of special concentration of each student, whether or not the Swarthmore honor course system is adopted.

The payment of a fee by each student applicant for admission to curtail the practice of applying in a dozen colleges with consequent waste of multiple records and acceptances.

The organization of a formal constitution.

The collection of all facts available about the life and work of each student to be accessible to psychologists and personal workers.

Limitation of the administrative personnel to men and women who are actually teaching classes.

Curtailing the costs in private colleges to meet the actual income, and installation of the unit cost system for balancing the final outlay. J. W. H.

What Is Chemical Engineering? H. A. CURTIS. *Ind. Eng. Chem.*, **19**, 257–8 (1927).—Discussing chemical engineering as an art, as a science, and as a branch of economics, C. points out that empirical practice in enterprises essentially chemical existed in ancient civilizations and far preceded the organized sciences of chemistry and physics. Development of the latter brought about the modern study of chemical engineering as a number of fundamental or "unit processes." In summary, it is an art requiring coördination of three essentials: "First, knowledge of the pertinent sciences and accumulated empirical data secured by laboratory research; second, skill and ingenuity in applying this knowledge to chemical enterprises; and, third, judgment in balancing values against costs." The second and third are fostered by "development research" on miniature and semi-plant scale production. Whereas chemical engineering involves some important phases not included in chemistry as a classical science, "the natural route to chemical engineering is through the field of chemistry" and "successful chemical engineers will always be able to qualify as chemists." V. R. T.

Black Science. GEOFFREY PARSONS. *Harpers*, **155**, 106 (June, 1927).—While the truly great scientist is not misled about the limitations of his knowledge the lesser mind is and in turn misleads. This is especially true of the popularizer of science who builds his eloquence about the scantiest frame of first-hand knowledge. A whole hierarchy of priests of reason has arisen to decry instinct and custom and insist that science and reason are sufficient lamps for our feet. And yet as far as the eye can see ahead man must do much by the old methods of judgment, trial, and error, aided by ancient customs, instincts, and institutions. When all the relevant facts have been digested and certain possible paths thereby eliminated the main problem remains—a ditch to be jumped.

It is in contact with religion that the exaggerations of science have created the greatest confusion. Scientists have claimed to have a complete substitute for religion. Today the common view of scientists is that religion and science are in no proper sense rivals. They explore the universe by different methods. Conflicts have arisen when they explored each other's fields. The invasions of religion by self-appointed priests of science are far more numerous and pernicious because seldom recognized. The true scientist should say he cannot disprove the miracles for none of them was of such a character as to leave an enduring record behind it. However, years of measurement and observation support the basic theory that ours is a universe of law.

We need to perceive and admit frankly the importance of the emotions of religion and the little that is understood as to their sources. It is difficult to isolate the part played by reason. The conception of science must be brought to bear upon religious faith but the processes should not disturb the emotions of faith.

The author believes that some day we shall be rid of the false gods that the magicians of science have summoned from their crucibles and be free to grow and prosper in spirit aided by all we have from the rich past of man. J. W. H.

Educational Responsibilities. J. M. GWINN. *Am. Educ. Digest*, **47**, 5 (Sept., 1927).—The original obligation and authority for conducting public education rest with the state and not with federal government or local units of the state. The office of the federal government is to encourage and aid but not control in any manner the state in the administration of its own educational program. The office of the local communities should be to execute the mandates and make effective use of the powers, duties, and privileges delegated to them by the state for the education of the children within their boundaries. Educational progress perhaps presents a more uneven front than social progress as a whole, hence a cross section of the meeting place of the state with local communities in supplying education will not be a straight line. Where there is great uniformity in the character of education required, the nature of the pupils and the amount of economic resources, the meeting place will be more nearly a straight line. With diversities in these elements the meeting line becomes irregular, reaching far over toward the local communities where conditions are most favorable and far over toward the state where conditions are more diverse and less favorable. J. W. H.

The Advance of the American School System. ANON. *Res. Bull. N. E. A.*, **5**, 195–223 (Sept., 1927).—The bulletin gives a brief summary of the actual work going on in the American schools and points out some of their ideals, achievements, and needs. A resumé of the progress in the following educational fields is included: Lengthening and enriching life; providing adequate school plants; school attendance; lifting teacher compensation to a professional level; developing a living curriculum; towards becoming

a nation of eighth graders; securing adequate school support; and general school effectiveness. A list of tables and charts is included. S. R. P.

Intelligence and Teaching, an Experimental Study. WILLIAM HENRY PYLE. *Educ. Admin. Superv.*, **8**, 433–48 (Oct., 1927).—The object of this study was to see what differences could be discovered between a group of very successful teachers and a group of failures. The experiment was carried out at Detroit Teachers College with several teachers of the two types referred to. The author compared two separate groups of very successful student-teachers with two groups of failing teachers; made experimental studies of 27 Teachers College freshmen considered by the training department as of doubtful teaching ability; made comparative studies of successful and unsuccessful teachers selected by the registrar on the basis of teaching grade records in the office, experimented with a class in educational psychology; and made a study of the college records and teaching success of the few very highest and few very lowest students as selected by the Freshman Intelligence Examination. Results from the study seemingly gave positive evidence that factors beside intelligence were of very great importance in teaching success, but the author ventures the opinion that an intelligence score below 90 on the Army Alpha or Detroit Intelligence Test would indicate that the chances for teaching success were very poor. S. R. P.

In Memory of Professor E. D. Campbell. M. GOMBERG. *Mich. Alumnus*, **34**, 40 (Oct. 15, 1927).—A bronze tablet, bearing the following inscription, has been placed in the main entrance hall of the Chemistry Laboratory of the University of Michigan.

Edward Demille Campbell. Devoted to the science of chemistry for over forty years. An able student and an honored teacher. Zealous in research. Undaunted by years of blindness he contributed nobly to life as well as to science.

Professor, 1893–1925. Director of the Chemical Laboratory, 1905–1925.

By this tablet his pupils, colleagues, and friends would do him honor and inspire those who read. E. R. W.

The Best Is Yet to Be. EDWIN E. SLOSSON. *Colliers*, **80**, 8–9 (Oct. 22, 1927).—In typical Slosson style this article leads the reader from one peak to another among the important contributions which science, in general, and chemistry, in particular, has made in the last century to "the very foundations of our lives." He calls attention to the fact that 1928 will be "the centenary of one of the most momentous achievements in the history of human progress," the preparation of urea by Wöhler in 1828. Thus the barrier which before that date had been assumed to divide the organic from the inorganic world was broken and progress in the synthesis of organic compounds has gone forward in leaps and bounds.

Nitrogen, in compounds useful either as explosives or as fertilizers, is removed from an endless source, the air. Cod-liver oil, or glass which is permeable to the ultra-violet rays, will increase our supply of eggs, or improve our health by the prevention of rickets in animals and man. Fruit and vegetables, left immature by a short or unfavorable season, may be ripened and colored by a mere trace of ethylene gas in the atmosphere.

The molecules which make up man and his machines may be manipulated by changes in temperature, pressure, and vibration. Temperatures attained range from —459°F. to 35,000°F., three times hotter than the sun; pressures from one billionth of an atmosphere to six hundred thousand pounds per square inch are at our service. At the higher pressure paraffin becomes hard enough to penetrate steel. Vibrations are already known with only a few gaps from radium rays, one-three hundred millionth of an inch in length, to radio waves, ten miles in length. With these ranges of control at hand the scientist is like "a man who had known no music except penny whistles suddenly given a chance to play on a pipe organ. At present he is merely trying the keys. But in the next century.....!"

Even the basic industry, agriculture, will not escape transformation; for the farm of the future will be devoted to the raising of weeds, the rankest growths possible, and from the great bulk of material thus obtained, "the chemist will sort out oils, sugars, proteins, and without waste turn them into food or fiber as may be needed."

E. R. W.

The Magic Hour in Chemistry. C. A. GORGAS. *High-School Teacher*, **3**, 331 (Oct., 1927).—The continuation of a series of demonstrations begun in previous numbers of this magazine. This instalment includes magic pictures, changing wine to water and our flag. Helpful reference is cited for the teacher interested in such demonstrations. B. C. H.

Laboratory Layouts for High-School Science. A. C. MONAHAN. *Bull.*, No. **22**, Bureau of Education (1927).—A timely pamphlet treating developments in high-school laboratories, their needs, wastes in laboratory space and class-rooms. Chemistry,

physics, general science, and biology laboratories are each given specific attention. Lecture-table equipment and equipment costs are included. B. C. H.

Over-Population of the Colleges. EDITORIAL. *School*, **39**, 126 (Oct. 13, 1927).—In the mind of the editor, the article of President James Rowland Angell of Yale University on "Over Population of the Colleges," is most confusing because it states a chaotic problem now facing every university and college in this country for which there seems, at present, to be no satisfactory answer. Young men and women today have a craving for a college education as never before. Some statistics of a few leading colleges show that only about one-fourth of the applicants are received.

Dr. Angell believes our present education is "shoddy and superficial" and that it is "permitting young people of the slenderest and most meager intellectual powers and achievements to go forward indefinitely in it." Accordingly he suggests a reconstruction of our whole educational program from the kindergarten up, stressing intellectual standards and the use in the upper ranges of competitive selection which has been so good for Yale. E. L. M.

What Should a Specialist Be? WILDER D. BANCROFT. *Chem. Bull.*, **14**, 239–40 (Oct., 1927).—Doctor Bancroft takes the opposite view to that of Dr. R. A. Gortner, in an address given before the local section of the Sigma Xi society, which expressed the popular idea that "we must become more and more a group of specialists centering our intensive study upon a narrower and narrower field."

A person must know something about everything if he is to know everything about something is the belief of Dr. Bancroft, and he gives several illustrations to show how apparently irrelevant facts in other fields of science have become invaluable in the particular study undertaken. Some of the illustrations given are: The Helmoltz-Young theory of color-vision, the calculation of osmotic pressure, the displacement of water equilibrium, peptization by alcohol, contact catalysis, activated molecules, etc. E. L. M.

The Improvement of Instruction through High-School Reorganization. J. H. HIGHSMITH. *High-Sch. Quart.*, **16**, 192–4 (July, Oct., 1927).—There is a detailed discussion of the three factors which make improvement possible, namely, curriculum, organization of the school, and the daily schedule. J. H. G.

Efficient Administration and Its Relation to Scientific Methods. COMMITTEE REPORT. *High-Sch. Quart.*, **16**, 206–11 (July–Oct., 1927).—The elements of efficiency in the administration of secondary education, such as enrolment, recruiting, attendance, retentive and promotional efficiencies, are discussed at length. There is a need for improved efficiency in secondary school administration. The position of the committee with regards to scientific methods as a basis for determining efficiency in administration is given, followed by means for applying same. Scientific methods have been employed more successfully in the field of elementary education than in the field of secondary education. At present and for some time in the future, attention must center around the improvement of instructional efficiency. J. H. G.

The Supervision of Teaching in the Junior and Senior High School. COMMITTEE REPORT. *High-Sch. Quart.*, **16**, 213–22 (July–Oct., 1927).—Supervision plays an important rôle in plans for reorganization. Five functions of effective supervision are given. These involve the oversight, direction and inspiration of teachers in the supervision of class teaching and class management. The report concludes with how supervision is administered and the factors conditioning efficient supervision. J. H. G.

The Administration Machinery for Secondary Education. COMMITTEE REPORT. *High-Sch. Quart.*, **16**, 222–26 (July–Oct., 1927).—Administrative problems are very different in small and large high schools. In the small high school, the principal is the chief administrator. In the large high school administrative problems involve the assistant principal, pupil affairs and activities, session-room teacher, departmental organization, the registrar, records and reports. J. H. G.

The Social Organization and Internal Government of the High School. COMMITTEE REPORT. *High-Sch. Quart.*, **16**, 226–35 (July–Oct., 1927).—The school should be a laboratory of democracy and ethical training. The principal, teachers, and pupils, as members of the school community, should participate and coöperate in all activities of the school. J. H. G.

The High-School Principal. COMMITTEE REPORT. *High-Sch. Quart.*, **16**, 235–39 (July–Oct., 1927).—The desirable qualifications for a principal are given. For the present time, the principal should be a man. The function and the apportionment of time of the principal are discussed at length. Tables of actual apportionment and of the desired apportionment of the principal's time are given. J. H. G.

Local Activities and Opportunities

Wisconsin Teachers' Association. The Chemistry Section of the Wisconsin Teachers' Association held a meeting in Milwaukee, on November 4th.

Dr. P. N. Leech, of the American Medical Association, spoke on "Home Remedies, Claims *vs.* Composition," and presented some very enlightening material on the subject.

Prof. P. W. Boutwell, of Beloit College, spoke on "What the Chemistry Teacher Should Read." Prof. H. A. Webb, of Peabody College made a plea for greater emphasis upon organic chemistry even in elementary work.

The following officers were elected for the coming year: *Chairman:* A. P. Minsart, Wausau High School, Wausau; *Secretary:* Isabel Henkel, West Division High School, Milwaukee; *Senator:* H. B. Merrill, A. F. Gallun & Sons, Milwaukee; *Contributing Editor:* Vera M. Templin, Baraboo, Wis.

Florida. The sixteenth meeting of the Florida Section, A. C. S., was held in Gainesville on Saturday afternoon and evening, November 12th. The program was as follows:

AFTERNOON SESSION

3.00 to 4.00 P.M. Inspection of new Chemistry-Pharmacy Building.

4.00 to 4.30 P.M. Business meeting.

4.30 to 5.30 P.M. Address—"The Action of Certain Chemicals on Citrus," by Mr. Gray Singleton, Manager and Chief Chemist, Independent Chemical Company, Ft. Meade, Fla.
Address—"Impressions of the First Institute of Chemistry," by Mr. W. F. Dahl, Assistant State Chemist, Tallahassee.

6.30 to 7.30 P.M. Dinner at Primrose Grill.

EVENING SESSION

8.00 P.M. Address—"Thomas Green Clemson, Chemist," by Dr. R. N. Brackett, Director, Department of Chemistry, Clemson College, S. C.

Officers elected for the coming year are as follows:

Chairman, Prof. A. P. Black.
1st Vice-Chairman, Prof. O. J. Sieplein.
2nd Vice-Chairman, Mr. S. S. Walker.
Sec.-Treas., Prof. R. C. Goodwin.
Councilor, Prof. R. S. Bly.

These men assumed the duties of their offices on December 1, 1927.

Harvard University. The New England Association of Chemistry Teachers held its 107th meeting at Harvard University on December 3rd. The program was as follows:

Morning Session

9.45. Trip to Lever Brothers Soap Company

12.30. Luncheon at Colonial Club, Cambridge

Afternoon Session

1.30. Business meeting

2.00 "Photochemical Experimentation." Dr. George S. Forbes, Harvard University

2.45. "A New Theory of Electrolytic Dissociation." Dr. Grinnell Jones

3.15 "How the Blood Carries Oxygen." Dr. James B. Conant.

Carnegie Institute of Technology. A five years' program of scientific studies in the physical chemistry of steel making to be carried out by the Carnegie Institute of Technology, the U. S. Bureau of Mines, and an advisory board of Pittsburgh steel executives and metallurgists has been launched. Twenty-six steel companies located east of the Mississippi river will coöperate in the work.

Pledges of support in undertaking the research program were given by 65

representatives of the 26 coöperating steel companies at a dinner given for them and members of the advisory board by President Thomas S. Baker at the Carnegie Institute of Technology on October 19th. The dinner meeting was preceded by inspection in the afternoon of the metallurgical laboratories of the Bureau of Mines and the laboratories of the Department of Metallurgy and the Bureau of Metallurgical Research at Carnegie Institute of Technology.

Speakers at the meeting included Dr. Thomas S. Baker, president of Carnegie Institute of Technology, Dr. John Johnston, director of the Department of Research and Technology, United States Steel Corporation, Scott Turner, director, U. S. Bureau of Mines, and Dr. C. H. Herty, Jr., head of the Ferrous Metallurgical Section of the U. S. Bureau of Mines, who gave a progress report on the coöperative research.

Official announcement that a second International Conference on Bituminous Coal will be held during the week of November 19, 1928, has been made.

Decision to call a second congress of world scientists and fuel technologists has been made, it is announced, as a result of the widespread interest aroused throughout the world by the first Conference on Bituminous Coal held at the Carnegie Institute of Technology in November, 1926.

The first conference, which was devoted to discussions of the better utilization of bituminous coal, was attended by 1700 persons, including delegates from thirteen different countries. Among the distinguished European scientists who addressed the conference were Dr. Friedrich Bergius, Heidelberg, Germany; Professor Franz Fischer, director, Institute of Coal Research, Mulheim-Ruhr, Germany; General Georges Patart, Paris, France; Dr. Cecil H. Lander, director of fuel research, Dr. R. Lessing, consulting engineer, Geoffrey M. Gill, consulting engineer, and Harold Nielsen, London, England.

Although no definite program plans for the second conference have been made, it is expected that the 1928 session will cover the latest developments in obtaining substitutes for gasoline from coal, power from coal, low and high temperature distillation processes, smokeless fuel, gasification of coal, utilization of coal-tar products, coal as a source for fertilizer, and coal in relation to the production of fixed nitrogen.

Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, who called the first conference, visited Europe this past summer for the purpose of discussing phases of the second conference with eminent scientists in France and Germany. He plans to pay another visit to Europe in 1928 to invite speakers and delegates.

"Engineering as a Profession" is the title of a new bulletin issued by the Carnegie Institute of Technology in Pittsburgh. The author is William E. Mott, director of the College of Engineering. In connection with the bulletin, sets of stereopticon slides have been prepared to illustrate the points emphasized in the contents.

Copies of the bulletin or sets of slides, or both will be sent to any high school or educational groups interested, for presentation before groups of interested students, by applying to Alan Bright, Registrar, Carnegie Institute of Technology, Pittsburgh, Pa.

University of Pittsburgh. In the November number of THIS JOURNAL announcement was made in these columns of the novel seminar program arranged for the year 1927-28. Through an oversight, only a partial list of institutions to be discussed on successive Fridays under the general topic, "American Universities and Their Work in Chemistry," was included. The complete list follows:

Illinois, Cornell, Columbia, Ohio State, Pennsylvania, Johns Hopkins, California Inst. of Tech., Toronto, Leland Stanford, Yale, Michigan, Pennsylvania State College, Oberlin, Northwestern, Minnesota, Harvard, Iowa, Washington (State), Princeton, Massachusetts Inst. of Tech.,

California, Brown, McGill, New York, Kansas, Chicago, Cincinnati, Rice Institute, Wisconsin.

The University of Pittsburgh studio of station KDKA is broadcasting a series of radio talks on Wednesday evenings from 7.00 to 7.15 P.M. The following talks have already been delivered:

Nov. 30th, "His Job and How He Goes about It," Dr. Stegman.

Dec. 7th, "Grinding Away: Abrasives," Dr. Roche.

Dec. 14th, "The Newer Protective Coatings," Dr. Baldwin.

Future papers will be delivered as follows:

Dec. 21st, "Making Pictures—After the Snapshot," Dr. Hiort.

Jan. 4th, "Like Ivory and Amber: Condensation Products," Dr. Cornwell.

Jan. 11th, "Approved Food Colors," Dr. King.

Jan. 18th, "[illegible]g Medicines," Dr. Lowy.

Jan. 25th, "Radium: From Watch Dial to Hospital," Professor Silverman.

Princeton University. Dr. Graham Edgar, director of research of the Ethyl Gasoline Corporation, lectured to the Princeton Chemical Club on Thursday, November 17th. The subject was "Theories of Antiknock Action."

Professor H. S. Taylor lectured before the Swarthmore Section of Sigma Xi on Tuesday, November 15th. The subject was "Catalysis."

Professor A. W. C. Menzies lectured before the Royal Canadian Institute in Toronto on December 10th. His subject was "Atoms and How They Combine."

Professor H. S. Taylor will be the lecturer at the March meeting of the Virginia Section of the A. C. S. at Charlottesville, Va.

Robert F. Mehl, Ph.D., Princeton, 1923, has recently been appointed director of the Naval Research Laboratory at Anacostia, D. C.

A joint meeting of the Princeton Chemical Club and the Princeton Section of the American Chemical Society was held on Thursday, November 3rd. Dr. Frank C. Whitmore, Chairman of the Division of Chemistry and Chemical Technology of the National Research Council, addressed the meeting on the subject of "Some Uses of Organic Mercury Compounds in Synthetic Chemistry."

South Dakota. The South Dakota Science Section of the S. D. E. A. met at Aberdeen from November 21st to 23rd, inclusive. The program presented was as follows:

Theme: The Place of Science in the Modern High School.

"The Place of Science in the Modern High School," Earl R. Glenn, Lincoln School of Teachers College, New York City.

"Home-Made Physics Apparatus," G. H. Hyde, White Lake.

"Garvin Prize Essay Contest," B. A. Dunbar, Brookings.

"Term Paper Practices in Teaching Chemistry in the High Schools of the United States," Ralph E. Dunbar, Mitchell.

"Chemical Warfare," C. F. Wells, Brookings.

"The Purple Cap—What Does It Signify?" Carl Grugn, Ipswich.

The program was followed by a luncheon in the College Cafeteria at which time approximately one hundred guests were served.

Industrial excursions were made on November 22nd to the printing plant of the "Dakota Farmer," and the "Seybright Greenhouses." On November 23rd, similar excursions were made to the "City Bakery," "Dakota Central Telephone Exchange," and the "Crescent Bottling Works." This feature of the program was under the direction of J. H. Jensen of Aberdeen.

Officers elected for the next year include J. H. Jensen, Aberdeen, *President;* Charles Dalthorp, Aberdeen, *Vice-President;* Ralph E. Dunbar, Mitchell, *Secretary-Treasurer;* A. M. Pardee, Vermillion, and B. A. Dunbar, Brookings, members of the Executive Committee.

Recent Books

General Chemistry. LEON B. RICHARDSON, Professor of Chemistry in Dartmouth College. Henry Holt and Co., New York, 1927. viii + 812 pp. 99 figures. 14 × 21.5 cm. $3.75 postpaid.

"The form and method of treatment of the material contained in this book come from an experience lasting over a considerable period in the teaching of general inorganic chemistry to college students. From that experience the writer is convinced that the text is the vital element in such instruction. Lectures have their place in affording illustrative material, and discussion of topics to which the student has already been introduced; as the core of this work, the point around which the course really centers, they are pitiably ineffective. The student, if he is really to master the subject under discussion, must mull over it at leisure. He cannot, in general, grasp it on the wing, and retain it as it comes even from the best of lecturers. As a consequence of this belief, this book is rather more full and detailed in its explanation than sometimes is the case. Much material of an illustrative and explanatory character, commonly confined to lectures, is included in it. The length is due to that factor rather than to a greater variety of topics treated."

The book contains 46 chapters in which the author has presented the fundamentals of chemistry and its modern developments and applications. The order of presentation is usually that of the conventional development of the subject. The most outstanding exception to this order is the early presentation of sulfur with its oxides and acids. Sulfur and hydrogen sulfide are discussed in chapter 12 immediately after the chapters dealing with "Atomic Weights;" "Valence, Nomenclature, Calculations;" and "Solutions." The question of "The Energy Factor in Chemical Change" and "Chemical Equilibrium" are then discussed in two well written chapters and followed by a chapter on oxides and acids of sulfur.

The chapters on "Electrolytic Dissociation," "The Periodic System," "Oxidation and Reduction," "The Structure of Atoms," and "Electromotive Chemistry" are especially worthy of mention. The closing chapters deal with carbohydrates, animal nutrition and synthetic organic compounds.

There are many outstanding and commendable features of the book. The style is clear and sufficiently informal to make it very readable. The numerous and excellently written historical sketches will be a valuable aid in sustaining the interest of the student. The chapters are followed by skillfully selected bibliographies and review questions. Both of these features will be greatly appreciated by the student who is really interested in the subject.

The sections are numbered and cross references are numerous. The appendix contains useful data in tabular form. One of these tables is especially worthy of notice. It is a table of the common industrial alloys and their compositions. The index is especially comprehensive.

The author has made a valuable contribution to the list of modern textbooks devoted to the teaching of general chemistry. This book is an excellent example of good workmanship and the author and the publishers are to be congratulated upon its publication.

A. E. MCKINNEY

Standards and Tests for Reagents and C. P. Chemicals. BENJAMIN L. MURRAY. 2nd Edition. Revised and Enlarged. D. Van Nostrand Co., Inc.,

New York. 1927. xiii + 560 pp. 15 x 23 cm. $5.00 net.

The second edition of this well-known work will be welcomed by all chemical laboratories employing reagents of defined purity. The material on reagent chemicals has been revised in the light of experience and standards of purity and methods of testing added for over 200 C. P. chemicals. 497 chemicals are described ranging from acetone to zinc sulfide.

The plan of treatment is familiar to all, following in general the earlier works of Krauch and Merck, although much more elaborate than either. Following some paragraphs on physical properties, influence of light and air, uses and storage, come the maximum limits of impurities allowable and finally the detailed methods of testing. The limits of impurities allowed are such as it is practicable to maintain in practice. There is included an introductory chapter on the reagents and tests used in the tests described and an appendix of several specific gravity-composition tables.

The tests are carefully worked out and described in such detail that even a beginner can use the book with confidence. The author's extensive experience as head of the control laboratories of Merck and Company enables him to speak with authority. The general appearance and type size is most pleasing. It is a defect that extensive literature references are not included but perhaps this is too much to expect in a work of this character. "Murray" will undoubtedly become the final authority for many a chemist.

MALCOLM M. HARING

A Course in General Chemistry. WILLIAM MCPHERSON AND WILLIAM EDWARDS HENDERSON, Professors of Chemistry, Ohio State University. Third Edition. Ginn and Company, New York, 1927. xxiii + 684 pp. 221 figs. 16 x 23.5 cm. $3.40.

This book is intended for an introductory course in chemistry for college students. Since its original printing in 1913, the book has enjoyed such widespread use that a detailed description of the purpose and spirit of the work is hardly necessary. Suffice it to say that the authors have, in the third edition, continued their policy of presenting a textbook that is both "scientific in spirit and thoroughly teachable."

To keep pace with the newer developments in chemical science and with the changing methods of presenting the subject to the student, the authors have altered, somewhat, their previous order of presentation of the various subjects. A brief chapter on the history of chemistry has been introduced at the beginning for the purpose of acquainting the student with the human side of the science. This is followed up by historical notes and paragraphs under each of the subjects treated. In the opinion of the writer this should greatly help to arouse the interest of the student and will assist him in developing the proper chemical point of view. The concepts of matter and energy are developed in the second chapter. Then follow the usual chapters on oxygen, hydrogen, gases and the gas laws, water and hydrogen peroxide, the atomic theory and atomic weights, and equations and calculations. A chapter on carbon and its oxides is next presented, a bit earlier than is usual, but to decided advantage. Then come chapters on nitrogen and the inert gases and on the atmosphere.

Following the modern trend in teaching, the authors then introduce a chapter on the structure of the atom. This subject is adequately treated and is presented at an opportune time, *i. e.*, well toward the beginning of the course. The student is no longer left in the dark concerning the intimate structure of the substances about which he is learning. The recent work and ideas of Rutherford, Bohr, Lewis and Langmuir are discussed. This chapter is followed very naturally

by one on the states of matter. Herein is included a section on crystal structure as gleaned from recent X-ray diffraction measurements. In the chapter on the Periodic Law, along toward the middle of the book, the student is made acquainted with some of the recent work on isotopes. It is interesting to note that in the first edition the compounds of carbon received notice in only two chapters. Now, the subject matter is almost doubled and chapters on the hydrocarbons and petroleum, carbohydrates and coal-tar compounds, and on fats, oils and foods have been added. The metals are treated much the same as previously. Colloids and the purification and softening of water receive treatment in special chapters. The section on electric cells has been made more adequate than formerly. The authors fight shy, whenever possible, of the use of electrons and ions to explain oxidation-reduction reactions. They justify this on the grounds of simplicity, to avoid introducing mechanisms of reaction. It is a question in the reviewer's mind whether it would not then also be wise for the authors to omit the use of "nascent" oxygen (O) and "nascent" hydrogen (H) in their explanations of some oxidation and reduction reactions.

Each chapter has an appended list of questions and arithmetical problems. These seem to be more than adequate to make the student both review what he has read and apply his newly acquired knowledge. Important statements and laws, in the reading matter, have been set in italics to make the subject easier to review. In the opinion of the reviewer bold-faced type would help still more in this direction. The printing, binding and paper of the book are of better than average quality. The numerous, excellent illustrations, especially of industrial processes, should greatly assist the student to visualize that about which he is reading.

WILLIAM F. EHRET

The Methods of Organic Chemistry. C. W. PORTER, T. D. STEWART AND G. E. K. BRANCH, Members of the Faculty of the College of Chemistry in the University of California. Ginn and Co. Boston. First Edition, 1927. iv + 311 pages. 14 x 20.3 cm. $2.50.

In reading this book one is impressed by two outstanding features which distinguish it from many other laboratory manuals in this field. One is that it covers a large range of subject-matter as is shown by the titles of the chapters, namely:—Mechanical Operations; Organic Preparations; Class Reactions—A System of Qualitative Analysis; Acids, Bases and Indicators; and Quantitative Analysis. It is suitable for either a long or short course. With a little additional aid from an instructor on making derivatives and working with mixtures, it could be used for a course in qualitative organic analysis.

Directions for the preparation of some fifty-three compounds are given. These are clearly presented and so selected as to give the instructor considerable choice. Questions intended to stimulate reference work follow each preparation.

The other feature of the book is the space given to theory. This is especially noticeable in the chapter on Mechanical Operations and the chapter on Acids, Bases and Indicators, the latter being entirely a theoretical discussion.

There are 102 Review Problems and a useful appendix at the end of the book.

J. W. HOWARD

Introduction to the History of Science. Volume I. From Homer to Omar Khayyam. GEORGE SARTON, Associate in the History of Science, Carnegie Institution of Washington. Published for the Carnegie Institution of Washington by the Williams and Wilkins Company, Baltimore, 1927. xi + 839 pp. 17.5 × 25.8 cm. $10.00.

This volume is the first of a projected series of eight or nine volumes which will give a complete chronological survey of the history of science in the form of cross-sections of the civilization of each half century. The work is the first of its kind which has been attempted. When completed it will be such that future scholarship will perhaps modify and correct it, future discoveries will add to it—but it will not need to be rewritten. Sarton's book has about it the same finality which characterizes a volume of Gibbon's "Decline and Fall of the Roman Empire."

Every man of science will find much of interest to him in the Introductory Chapter. Every person of culture will find throughout the book passages which widen his vistas, increase his sympathy, and heighten his appreciation. The quotation behind the title-page truly represents the work—*Homo sum, humani nihil a me alienum puto.*

"The purpose of this work is to explain briefly, yet as completely as possible, the development of one essential phase of human civilization which has not yet received sufficient attention—the development of science, that is of *systematized positive knowledge.* I am not prepared to say that this development is more important than any other aspect of intellectual progress, for example, than the development of religion, of art, or of social justice. But it is equally important; and no history of civilization can be tolerably complete which does not give considerable space to the explanation of scientific progress. If we had any doubts about this, it would suffice to ask ourselves what constitutes the essential difference between our and earlier civilizations. Throughout the course of history, in every period, and in almost every country, we find a small number of saints, of great artists, of men of science. The saints of to-day are not necessarily more saintly than those of a thousand years ago; our artists are not necessarily greater than those of early Greece; they are more likely to be inferior; and of course, our men of science are not necessarily more intelligent than those of old; yet one thing is certain, their knowledge is at once more extensive and more accurate. *The acquisition and systematization of positive knowledge is the only human activity which is truly cumulative and progressive.* Our civilization is essentially different from earlier ones, because our knowledge of the world and of ourselves is deeper, more precise, and more certain, because we have gradually learned to disentangle the forces of nature, and because we have contrived, by strict obedience to their laws, to capture them and to divert them to the gratification of our own needs.

"My work contains but very few references to political or to economic history.—We are not interested in the pathological history of mankind.* * *

"The Greeks had taught the nobility of scientific study and that the pursuit of disinterested knowledge is the greatest purification; the Romans had urged the necessity of applying knowledge to immediate needs; the Christians were now insisting that if we have not charity it profits us nothing. The Greeks laid stress upon truth and beauty; the Romans upon strength and usefulness; the Christians, upon love.* * * Most of the people who finally understood that charity was essential did not stop there, but jumped to the conclusion that it was all-sufficient. This led them to consider scientific research not only useless, but pernicious. Thus the ruin of science, begun by Roman utilitarianism, was in danger of being completed by Christian piety. It has taken about one millennium and a half to make people understand that knowledge without charity and charity without knowledge are equally worthless and dangerous; a great many people do not understand it yet * * *.

"The historian of science cannot devote much attention to the study of superstition and magic, that is, of un-

reason, because this does not help him much to understand human progress.* * * Human folly being at once unprogressive, unchangeable, and unlimited, its study is a hopeless undertaking. It appears clearly * * * that the history of astrology must be carefully considered and that a large part of it is so intimately connected with the history of science that it cannot be dissociated from it. This remark applies with even greater force to alchemy, for in this case there was considerably more scope for the continual integration of new experimental facts, which were valuable in spite of wrong interpretations. Indeed, good experimental facts have a permanent value: they might be compared to the indestructible stones of a building; the building, that is, the scientific system, is bound to become obsolete and to be wrecked sooner or later, but the good stones will be used again for the new building. Thus did the alchemical facts outlast the alchemical structure; many of them are now integral parts of our chemical knowledge * * *.

"Science is reason organized and systematically applied. Religion is a reasoned and not unreasonable abdication of reason with regard to problems which *are not* amenable to scientific treatment. There can be no conflict between science and religion, except when they trespass on each other, as, for example, when theologians would extend the mental surrender to questions which *are* amenable to scientific treatment * * *.

"Science is essentially a system, but instead of being, as it was for the schoolmen, a closed system, it is never closed, but always subject to revision or even to complete discard. The true scientist considers his theories not as perfect and permanent, but as essentially incomplete and precarious; he is ever ready to abandon any part or the whole of them, should new experimental facts make it necessary. There are scientific methods; there are no scientific dogmas; there is no scientific orthodoxy* * *. Science is not a being, but a becoming. Thus the love of science is not the love of this or that system, which is bound sooner or later to be superseded by a better one, but simply the love of truth."

There is much more in the Introductory Chapter which I should like to quote, but I have quoted enough to show what it is like. Read the book.

The first numbered chapter deals with the ninth and eight centuries, B.C., the next three with the seventh, sixth, and fifth centuries, B.C., respectively, and the remaining chapters with half centuries down to the second half of the eleventh century, A.D. Each chapter commences with a panoramic survey of the science of its period. This is followed by sections which deal with special topics. Chapter XVIII, for example, the second half of the third century, is entitled "The Time of Diophantos" and has subdivisions which treat the Religious Background, Hellenistic and Chinese Philosophy, Hellenistic and Chinese Mathematics, Chinese and Hellenistic Astronomy, Hellenistic and Chinese Chemistry and Physics, Hellenistic, Roman, and Chinese Natural History, Roman, Hellenistic, and Chinese Geography, Chinese Medicine, Chinese Historiography, Roman Law, and Chinese and Greek Philology. The section on chemistry and physics recounts the important facts about Zosimos and the early chemical papyri, tells of the texts and translations, and gives references to critical comment. By this arrangement Sarton's book constitutes, among other things, a history of each of the special sciences during the period of which it treats. It will be indispensable to a student of any one of them—his guide to the way and his chart of the seas beyond his immediate ken.

Here indeed is "a book that is a book," a monument to the scholarship and humanism of its author.

TENNEY L. DAVIS

Laboratory Manual Of General Inorganic Chemistry. M. CANNON SNEED, Professor of Chemistry, U. of Minnesota.

and RAYMOND E. KIRK, Assistant Professor of Chemistry, U. of Minnesota. Ginn & Company, Boston. First edition, 1927. xvii+181 pp. 61 figures. 13.5×20.5 cm. $1.20.

A laboratory manual written to accompany "General Inorganic Chemistry," by the senior author, reviewed in a recent issue of THIS JOURNAL.

"More experiments are included than will normally be performed by any single class. Topics of a diversified nature have been selected to give the instructor choice of material suitable to the purpose of his course. Instead of adhering to the customary practice of directing students to use 'a little of this' or 'some of that' reagent, we have thought it more in keeping with the tenets of an experimental science to give specific directions wherever possible."

The manual includes a set of preliminary laboratory directions, 246 experiments and preparations, and an appendix consisting of 10 pages of necessary tables. The experiments are grouped under the chapter headings of the text which the manual is written to accompany, though in arrangement and subject-matter it is suited for use with any standard college text. The excellent figures should prove of material assistance to the student in correctly setting up his apparatus. An adequate number of quantitative experiments is included, mostly in the first half of the manual. Each group of experiments is followed by a number of study questions and problems.

The material is well arranged and carefully selected, the directions are clear and concise, and the manual, while differing in no essential respect from many another, is excellently adapted for use by beginning students.

A. P. BLACK

Microbiology of Cellulose, Hemicelluloses, Pectin and Gums. A. C. THAYSEN AND H. J. BUNKER, Oxford University Press, New York, 1927. viii + 363 pp. 13.5 x 22 cm. $8.50.

The book is well divided into four parts, the first listing the general properties and importance of cellulose, hemicelluloses, pectin and gums; the second consisting of brief descriptions of the microörganisms associated with the decomposition of these carbohydrate substances, and including Schizomycetes, Actinomycetes, and Eumycetes; the third dealing with the processes involved in the decomposition of these substances as found in flax and hemp (retting), manure, hay and straw, wood, fabrics, peat and coal, and in the plant destruction in the animal intestine; and the fourth briefly referring to industrial applications not included in the first three sections. A wealth of information has been condensed into 350 pages, with a few illustrations to augment the brief descriptions of microörganisms. These descriptions are frequently too brief to serve the worker as the basis for the identification of unknown species, but the classification can be of much value in dividing the field for the beginner. The copious literature references will greatly aid the student of the subject and indicate careful and thorough work on the part of the authors. Many weaknesses in the work of the past and the manifold problems yet unsolved are carefully pointed out. It is not a textbook, but is all that the authors claim, "a comprehensive account of the information available * * * * compiled from the point of view of the research worker who desires to know in what direction his efforts may most profitably be directed."

L. H. JAMES

A Guide to the Literature of Chemistry. E. J. CRANE AND AUSTIN M. PATTERSON. John Wiley and Sons, Inc. New York, 1927. v + 438 pp. 14.5 × 23 cm. $5.00.

The book is not only a "Guide to the Literature of Chemistry," but has sign posts along the way. One does not

follow the guide blindly but finds the way illuminated by appropriate subdivisions, the significance of which the authors have carefully explained.

The plan of the book "(1) production, (2) distribution and (3) use of the literature of chemistry" is closely followed. Compilations under the headings: "Books," "Periodicals," "Patents," "Other Sources," "Indices," and "Libraries," include material originating in all languages and compose the bulk of the book. Although the aim is to aid one in the efficient use of the literature of chemistry, one cannot read it without becoming aware of the great mass of the literature which is available to the chemist. Some of the bibliographies and compilations of data concerning this literature have previously been done, sometimes well and sometimes poorly, but have appeared in various publications making any efficient use of them impossible. The authors have brought all such material together, discarded that poorly done, eliminated duplication, extended that which was incomplete and organized it into a very efficient tool.

In short, the chemist will find the book a guide to how to obtain various publications, and will receive many helpful suggestions on how to use the literature with which he is more or less familiar.

After reviewing the book one's initial feeling of bewilderment at the voluminous source of the literature of chemistry is somewhat appeased by a feeling that even that has its limit.

The bringing together and organizing of such a mass of material has been an enormous task and the authors are to be congratulated upon its masterful completion.

CLIFFORD D. CARPENTER

METERED COMBUSTION CONTROL

Metered Combustion Control as used at the Manchester Street Station of the United Electric Railways Co., Providence, R. I., is described in a paper by A. S. Davis, Superintendent, which has been reprinted and is being distributed by the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. The rate of combustion is regulated according to the steam demand by a master controller connected to the steam header so that it responds to drop in pressure due to flow of steam and sets up an electrical control current proportional thereto. This current coöperates with control devices which actually meter the pulverized coal and the air supplied to burn it, to hold the two in a definite ratio and in proper amount to meet the steam demand. It is stated that the use of this equipment has resulted in more uniform steam pressure, and hence in more efficient operation of turbines, also in more uniform furnace conditions with lower excess air resulting in higher boiler efficiency and lower furnace maintenance. Finally, the operators have been relieved of practically all of the physical work of operating the boiler, with the result that they are now able to pay closer attention to the finer details and to the better operation of the plant as a whole. Charts from recording instruments show a remarkably constant percentage of excess air and a uniform steam pressure, in spite of a rapidly fluctuating steam flow incidental to load swings in a traction plant. The percentage of CO_2 is set to be maintained as high as is compatible with economical operation of the furnaces, taking into consideration maintenance, combustible in ash and combustible loss up the stack, as well as heat lost in flue gases.

"A FEW MOMENTS WITH THE BUSINESS MANAGER"

THANKS

During the past three years it has been a real pleasure to work with you. In every attempt to bring the JOURNAL OF CHEMICAL EDUCATION to the attention of prospective subscribers, to have the JOURNAL be of more service to each of its present readers, wholehearted and generous coöperation has been at all times extended.

There have been hundreds who have helped me in my work. There have been hundreds who, unknown to me, have gone out of their way to interest others in the JOURNAL OF CHEMICAL EDUCATION. To you all, please accept my sincere personal thanks for the many things you have done toward helping to make the JOURNAL OF CHEMICAL EDUCATION reach nearly six thousand paid subscribers during the past three years.

ERLE M. BILLINGS

COÖPERATION

With the January issue, The Chemical Foundation will take over the active business management of the JOURNAL OF CHEMICAL EDUCATION for the Division of Chemical Education.

It seems hardly necessary to point out to you what an important move this is. Here is an organization whose sole purpose is the extension of chemical education in the broadest sense and which almost from the beginning of the JOURNAL OF CHEMICAL EDUCATION has taken a deep and genuine interest in its promotion. This same organization has made available at cost, books of invaluable contents for use in our schools, colleges and to the lay public. At its head is Hon. Francis P. Garvan, who with Mrs. Garvan has made the American Chemical Society Prize Essay Contest possible. With the business management in such capable hands, it is hardly conceivable what wonderful benefits are in store for our present and future readers. By the same coöperation which you have manifested during the past three years, the JOURNAL OF CHEMICAL EDUCATION will become the most sought for and talked of magazine in the educational world.

ERLE M. BILLINGS

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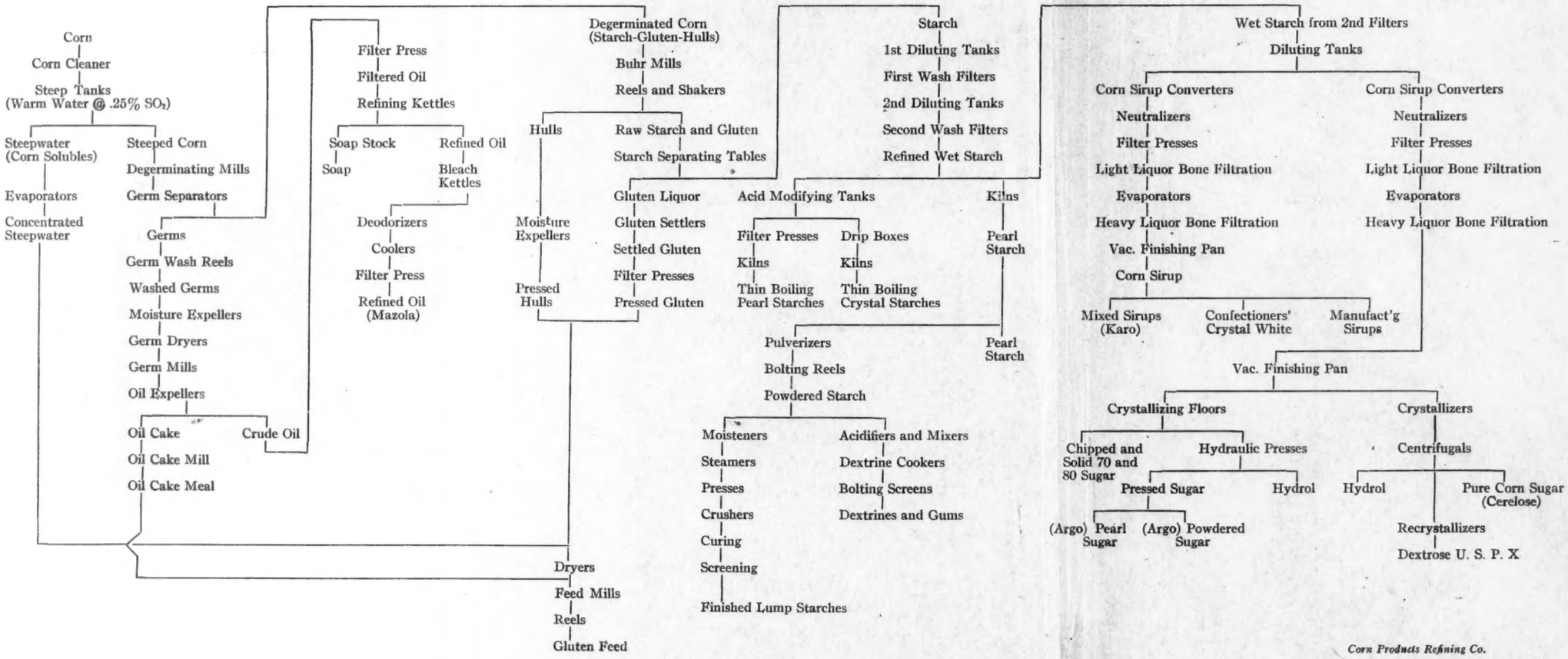
PROCESS FLOW SHEET



Corn Products Refining Co.

NUMBER OF GRADUATE STUDENTS IN VA[illegible] FIELD[illegible]1926, ACCORDING TO UNIVERSITY AND SUBJECT

"M" indicates those working for a Master's degree, "D" Doctor's degree, and "F" number on faculty engaged [illegible]

Universities by state	General and physical			Colloids			Catalysis			Subatomic and radio			Electro inorganic			Electro organic			Photochemistry and photography			Ind			Analytical			Metallurgical			Organic			Physical			Pharmaceutical			Pharmacological			Sanitary			Nutrition			Food			Textile			Industrial and Engineering			Total		
	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F	M	D	F
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Univ. of Ala.	1						1																					1			1																		2		1	5		3
Arizona:																																																					
Univ. of Ariz.	1		3																												2		2																	2		6
Arkansas:																																																					
Univ. of Ark.			2																														1																	1	6	8	14
California:																					1	1			2						1		1			1															1		1		2
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Mills College																																																					
Pomona Coll.			1																												1		1																	11	32	29
Stanford Univ.	6	3	3	5	3					1		1							4	1		2	1								2	1	4	2	5	6	3	2	2		2	2	2	3	1	1							
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Colorado:																																																					
Colo. Coll.																																																					
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Univ. of Denver	3		3																						2	1				3	3	4	1	3	3	2			1		1												
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Trinity Coll.	1		1																												2																						
Wesleyan Univ.			1				1		1																						2																		1	3	1	42	43
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Univ. of Del.	1		3																						2	1																												
District of Columbia:																																																					
Amer. Univ.			1																																																		
Catholic Univ.	1		1	1	1														2	1																																	
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Idaho:																																																					
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Illinois:																																																				
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Monmouth Coll.																																																				2
Northwestern	3	1	3	1					1																						1																		17	21	10
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Univ. of Ill.	6	8	2																5	1		5	1								10	19	5	3	1	2	2	2	3	1	1	1		6	5	3	1			3	3	3	59	47	28
Indiana:																			8	5			3	3							13	31	6		13	9						3	1	1									
Indiana Univ.																				7											25	18	3	15	7	7																	
Purdue Univ.			1																																																9	3	6
Rose Polytech.					1			2	1				4																																							11
Univ. of Notre Dame	1		1						1										1			4	1					1		1	1		2			1			1			5									2	1	5
Iowa:																			1														1																	1	5	1	6
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State Univ. of Iowa	3	7	3					1															1	7	2	1	2	1	1	1	1	1	2	5	3	1		7	1	4	16	5	4	4	3				19	63	15
Univ. of Dubuque				1									2										1	2	1	2	1				1	4	3		3	3	2	5	1	2				6		1		26	32	22
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Louisiana:													2	1																																							
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Johns Hopkins	1	12	3				1				3	2							1	1																																	1	1	7
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Holy Cross	4		1																												3		1		1	3																	
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Smith	1		1																1									1		2																					64	14	11
Tufts			1																												11	15	10	3	3	2																85	45	37
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New Jersey:																																																				2		3
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New York:																																																					
Albany Med. Coll.																																																				2		2
Colgate Univ.																															1																					1	1	4
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Columbia		10	15		9	1		1						1			2																26	6	7	6	11				5			5	3		5	1				19	24	7	26	94	50
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Univ. of Akron																																																					2		1
Univ. of Cincinnati			3												1		1			1			2							2	2	2	4	6	5															2		1	9	10	13
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Dickinson Coll.															1																																						3
Gettysburg Coll.																																																					1
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Haverford Coll.	1		1																1																																	2		1
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Swarthmore Coll.			1																																																8	2	9
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Univ. of Pittsburgh	2	5	2	1				1	1						1			1	2	3																																	4	13	18
Wash. & Jeff. Coll.	1		1		1														1	1		3	4		1					1	3			2	4	7		1						2	3	1			3		7	16	5
Rhode Island:																																																				1		1
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R. I. State Coll.																																																			2	1	1
South Carolina:																																																					
Clemson Coll.																																																			1		2
Coll. of Charleston	1																																																		1		
South Dakota:																																																					
S. D. State Coll.	1		1																																																2		5
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Tennessee:																																																					
Univ. of Tenn.			1																												3		1																	3		2
Vanderbilt Univ.[c]	2												1						1												3																					7		7
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Utah Agric. Coll.																																			1		1																1	5
Vermont:																																																					
Middlebury Coll.			1																												1		1																			1		2
Univ. of Vt.			2																														2		1																1	4
Virginia:																																																					
Roanoke Coll.	3		1																																																		1		
Univ. of Va.		2			1		2	3	2																																											5	3	1
Va. Polytech. Inst.																																																				3	5	6
Washington & Lee																																																				3		4
William & Mary Coll.	1																																																			1		3
Washington:																																																				1		
State Coll. of Wash.	2		1						1																																											3		9
Univ. of Wash.	2	1	1	2	1										1																1		4																			2	15	8	10
West Virginia:																		